MAR -3 1938

March 1938

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THE TABULAR VIEW

WRITING in The Review of last December, John E. Burchard, '23, said: "The work of Prescott and Underwood was outstanding in its comprehensiveness, in its accuracy, and in its fundamental nature. . . . There is no question but that the three classic papers of these two M.I.T. men in the years 1895 to 1898 marked the most important step [in the preservation of food] since Pasteur." The Prescott to whom Mr. Burchard referred is dean of science at the Institute, head of the Department of Biology and Public Health, and author of the article, "Putting Germs to Work," on page 215. Aside from his work as an educational administrator, Dean SAMUEL C. PRESCOTT, '94, has devoted his life to the applications of biology to industry. During the War he was in charge of food research and the problems of storage in Army training camps. In 1918–1919 he was in charge of the division of dehydration of the Bureau of Chemistry in Washington. For three years he was director of the research laboratory of the United Fruit Company in Costa Rica, where he made notable studies in food preservation, and for 17 years he was director of the Boston Biochemical Laboratory. ¶ In addition to his teaching activities in the Department of English and History at the Institute, FREDERICK G. FASSETT, JR., (page 220) is one of The Review's most dependable and stimulating contributors and one of the editors of Research Reports, published at the Institute. Only once in recent years has The Review included poetry (March, 1936), and at that time, too, Professor Fassett was the poet. ¶ ARTHUR C. WATSON (page 221) is secretary of, and technical adviser to, the committee on the Technology Museum. In this capacity he had charge of arranging the splendid Henry P. Kendall loan exhibition of whaling, now to be seen in Technology's Nautical Museum. Mr. Watson, sometime assistant curator of the New Bedford Whaling Museum, is an authority on the great whaling industry which once brought romance and wealth to New England ports.

A LETTER by Henry Bowen Brainerd of Wellesley, Mass., recently published in the *Harvard Alumni Bulletin*, seemed to us to be an unusually percipient statement of the objectives of The Review: "As I see it," wrote Mr. Brainerd, "the *Review* is primarily a good magazine in the modern style, edited for the type of men who graduate from M.I.T. and rather emphasizing news of the Institute. It is certainly a magazine which interests readers whether or not they are graduates of the Institute. In addition to news from Cambridgeport, it carries news of science and engineering from all parts of the world, generally with an alumni angle, but never with the alumni angle obscuring the news interest. Then it carries photographs, good photographs and lots of them, many by outstanding photographers, many that would win salon prizes. There must be an average of two photographs per page, and the technical nature of their subjects is not allowed to interfere with their quality as photographs. . . ."

No. 5

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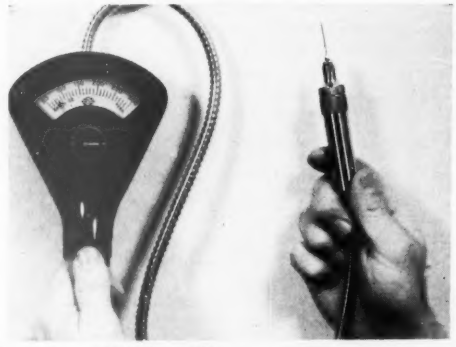

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LETTERS AND PICTURES FROM REVIEW READERS

Mercury Fountain

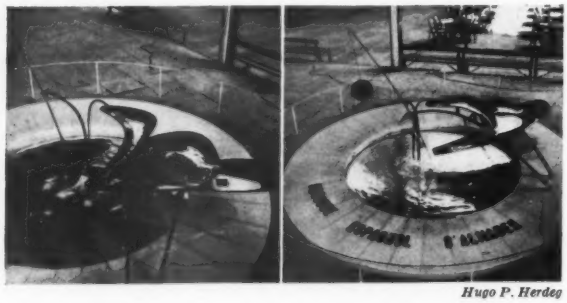
FROM WILLIAM B. F. DREW:

. . . Under the heading of "Paris Exposition" [November issue] your reporter missed a scoop, or was it because you just do not advertise your competitors?

Alexander Calder, one of the best of the modern artists, whose mercury fountain is illustrated, was a splendid engineering student and graduated from Stevens, Class of '19. It is too bad there was not a description of the working of that fountain, because it is very interesting — especially the finely balanced movements that were developed. If you look at the picture, you will note that it is a series of fulcrums and levers.

New York, N. Y.

FROM ALEXANDER CALDER:



Hugo P. Herdeg

The [above] photographs give a pretty good idea of the fountain. A pump and a reservoir were placed under the stairs in the inclosed part of the building, and a large pipe to take the mercury from the basin to the pump and a small one to bring it back, under pressure, from the reservoir to the fountain, were laid under the paving. Due to the weight of the mercury, the extreme height permitted me from which to spill it was about a meter. Also, as the mercury splashes and wastes itself in very fine globules in all directions when permitted to fall for more than two or three inches on another surface of mercury, it was necessary to keep the whole thing very low.

So I used three plates, of irregular form, and permitted the mercury to flow across one after the other, spilling over a lip at the end of each plate. This gave the spectator the opportunity to look down upon the surface of the mercury as it flowed and also increased the effective surface of the mercury and varied its forms.

There were also limitations as to material — those I was given to work with being glass and polished steel. But the basin was made of concrete, lined with pitch; so I discovered that that, too, was permissible. This was very fortunate, as pitch has a flat black surface, which gives the strongest possible contrast to the mercury, whereas glass or polished steel is much closer to the mercury in color value. So I made the plates of steel, and once they were in position, had the working surfaces covered with pitch, and the supports and under surfaces painted black. First I had the plates made according to my design, and then took them to the fountain, supported them on a falsework, and then designed the supports.

As the design, thus far, was low, and the movement very gentle, I added a mobile element, which would increase the movement, add color, and also give the name of the mines from which the mercury came. This was composed of a rod, slung from a spot near its center and ending in a flat plate of irregular form, at the bottom, whose weight was sufficient to support a second, finer rod and maintain a steep slope. The upper rod had at its bottom end a circular disk, painted red, and at its upper extremity it flaunted, made of a single piece of brass wire, the name of the mines, Almaden. . . . Thus there were five colors in the composition: brass, red, flat black, the gray of the stones, and the mercury.

The movement was caused by the jet of mercury flowing from the third plate, which was a sort of chute, with dams, tapping against the heavy plate, causing a swaying of the red disk and of the name Almaden.

Curiously enough, there was no mercury available at the time of the conception and construction of the fountain. So I bought some ball bearings and permitted them to flow over the surfaces of the small, rough model which I had made. And thus we were able to speculate as to what would happen with the mercury, once we had it. The mercury arrived exactly in the middle of the afternoon of the press opening of the pavilion. There were 200 liters valued, I was given to understand, at half a million francs. One hundred and fifty liters were put into circulation, and the rest held in reserve to take care of losses due to splashing, seepage, and so on.

Roxbury, Conn.

Any Number of Answers

IN December, Howard M. Edmunds, '05, submitted this problem: "There is one (and only one) set of five right triangles whose sides are all whole numbers and whose areas are all equal. What are they?" This brain teaser resulted in so much discussion that we requested Professor Philip Franklin of the Institute's Department of Mathematics to review it. Here is his response:

FROM PHILIP FRANKLIN:

The statement of the problem, "Find a set of five right triangles (there is only one) having integral sides and the same area," is inexact. Not, as some readers suggested, because there is no answer, but because there are any number of answers. In fact, it was pointed out by the French mathematician, Fermat, in 1640 that if a, b, c are three integral sides of a right triangle, so that $a^2+b^2=c^2$, then $4abc^2$, $c^4-4a^2b^2=(a^2-b^2)^2$, $c^4+4a^2b^2$ are the sides of a second right triangle having the same area as the one with sides $2ac(a^2-b^2)$, $2bc(a^2-b^2)$, $2c^2(a^2-b^2)$, formed from the first by scaling up the sides. This process may be repeated, starting with the second triangle, and scaling up the sides of the pair just found to obtain three, and so on. Thus the problem has a solution even if the five be replaced by some greater number, and one triangle of the set may be taken similar to any particular right triangle with integral sides.

The process just described leads to enormous numbers. If, for example, we start with 4, 3, 5 in place of a, b, c and form a set of five, the common area will be a number of more than 250 digits. We may obtain sets with a smaller common area by a modification of the process. We start with a set of three triangles of equal area, using a rule given by Diophantus of Alexandria (*circa* 300 A.D.). Diophantus observed that if x, y, z are three integers such that $x^2+xy+y^2=z^2$, then $2xz$, z^2-x^2, x^2+z^2; $2yz$, z^2-y^2, y^2+z^2; $2(x+y)z$, $(x+y)^2-z^2$, $(x+y)^2+z^2$ give integral sides of three right triangles, each of which has its area equal to $xyz(x+y)$. We note that all such sets x, y, z without common factors may be found by taking two whole numbers p (not divisible by 3) and q (having no factor in common with p) and putting $x=p(p+2q)$, $y=q(2p+3q)$, $z=p^2+3pq+3q^2$.

If we take $p=q=1$, and then use the process of Fermat on two of the three triangles, we find a set of five triangles with a common area $210(2\times29\times41\times23\times37\times47)^2$, approximately 1.9×10^{16}. If we write $A=29\times41$ and $B=23\times37\times47$, the area is $840A^2B^2$ and the sides are as follows: 21, 20, 29, each multiplied by $2AB$; 35, 12, 37, each multiplied by $2AB$; 112, 15, 113, each multiplied by AB; $2\times840\times841=2\times840\ (29)^2$, $(841)^2-(840)^2=41^2$, $(841)^2+(840)^2$, each multiplied by B; $2\times840\times1369=2\times840\ (37)^2$, $(1369)^2-(840)^2=(23\times47)^2$, $(1369)^2+(840)^2$, each multiplied by A.

E. G. Allen,'00, called my attention to the fact that the English puzzler, Dudeney, recently gave two sets of four triangles of the same area, with much smaller sides, by guessing a fourth triangle to go with certain triplets of Diophantus. For p, $q=1$, 3, the sides are 660, 259, 709, each doubled; 140, 1221, 1229, each (*Concluded on page 204*)

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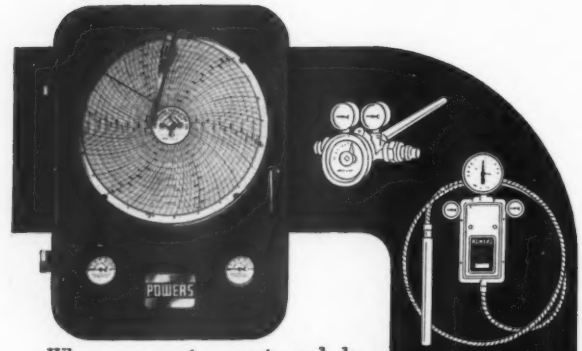
H. F. MARSHALL '19



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(*Concluded from page 202*)

doubled; 2960, 231, 2969; and the fourth, found by trial, is 6160, 111, 6161. For $p, q = 1, 5$, the sides are 4080, 1001, 4201, each doubled; 528, 7735, 7753, each doubled; 17472, 935, 17497; and the fourth, found by trial, is 1428, 715, 1597, each multiplied by 4. However, when we try to find a fifth triangle by Fermat's method to go with either set, the areas are, in the best case, about 2.3×10^{22} and 4.9×10^{25}, respectively, or somewhat larger than the area for the set given above.

But there are sets with smaller areas than that; for example, the set with area $2\times3\times11\times19$ $(3\times4\times5\times7\times13)^2 = 37383746400$, approximately 3.7×10^{10}. The sides are:

$176 = 16\times11$, $57 = 3\times19$, 185, each multiplied by $(2\times3\times5\times7\times13)$
$304 = 16\times19$, $297 = 3\times9\times11$, 425, each multiplied by $(2\times5\times7\times13)$
$132 = 12\times11$, $475 = 25\times19$, 493, each multiplied by $(3\times4\times7\times13)$
$836 = 4\times11\times19$, $1323 = 27\times49$, 1565, each multiplied by $(4\times5\times13)$
$32448 = 64\times3\times169$, $256025 = 11\times19\times25\times49$, 258073, each multiplied by 3

I obtained the foregoing by a tentative method involving the construction of a table of the first few hundred possible areas of integral right triangles having no large prime factors.
Cambridge, Mass.

Toward Better Automobiles

FROM ALFRED P. STEENSEN, '26:

While very much in sympathy with the goal of better automobiles, I find myself differing from the opinions in "Toward Better Automobiles" [December Review]. To begin with, I object to the use of the smear word, "gadget." This term appears to be indiscriminately applied to portions of the car not useful to the particular person. . . .

While yearly models introduce much waste, continuous improvement is desirable, and competition is inescapable. The 25-year car is unsound on at least three counts: The car of 25 years ago — 1913 — would not be popular today, even as a gift. The car of today, in 25 years, or 1963, will probably not represent the ultimate in transportation. The third point is that the extra cost of building for 25 years' service would bring the purchase price so much higher that the cars could not be generally sold. . . .

The criticisms of glaring headlights, difficult tire changing, and heavy corner posts appear to me to be justified. However, I question the danger in sloping, divided windshields. The middle barrier does not obstruct vision unduly, and the varying angle is little worse in the divided windshield. . . .

The criticism of the development of more comfortable automobiles is unfortunate. It is only recently that comfort has been considered in design, and while there have been unfortunate results, such as underestimation of speed, the present designs are far from the desirable limit. In all cars the rear seat, being virtually over the rear axle, is still less comfortable than the front seat near the middle of the wheel base.

I agree with Mr. Exley [February Review] that the modern car is unnecessarily heavy. As he says, eventually automobiles may advance with the technical sciences. Mr. Eaton ['17] appears to be very optimistic in hoping for control on ice comparable to control on dry pavement. However, improvement should be readily obtained, particularly by improved weight distribution. The overhanging rear end in the modern car appears to make rear-wheel skids more common, outweighing the advantages of four-wheel brakes. Mr. Miller ['02] appears to have described the Stout Scarab — without overhang of body over wheels, and engine in rear. Broadly, his suggestion appears reasonable — larger inside and smaller outside. At the present time the price limitation seems to rule it out. Mr. Whitmore ['38] seems to feel that now that the better automobile has been specified, some manufacturer should make it. This car must be free from gadgets, not too comfortable or powerfully engined, with bumpers on all four sides, internally operated jacks, and summer cooling devices. On the contrary, it appears that scientists and engineers are essentially no different from other car owners. They have their prejudices and pet peeves, and one engineer's meat is some scientist's poison.
Sharon, Mass.

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From a photograph by Robert Yarnall Richie, Courtesy Oil Well Supply Company

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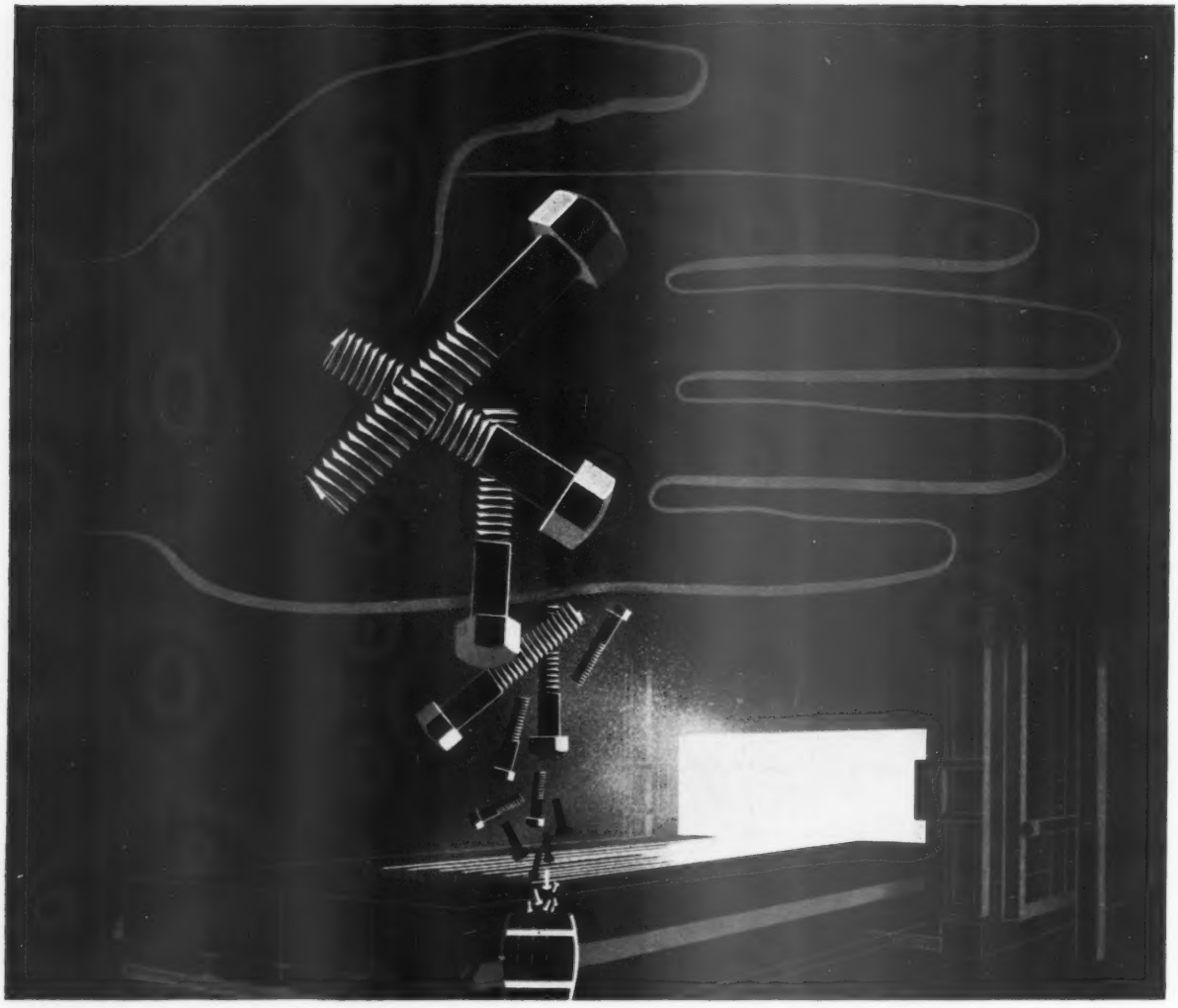

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MAR -3 1938

THE
TECHNOLOGY
REVIEW

Vol. 40, No. 5 March, 1938

The Trend of Affairs

Wetter than Water

SOAP owes its detergent action to the fact that the long molecules which it contains have, at one end, a group which is soluble in water and, at the other, a group which is soluble in fats and oils. Sodium stearate, the principal ingredient of any hard soap, has the acidic carbonyl group's sodium salt, soluble in water, at one end of its molecule, while the rest of the molecule consists of a long chain of 17 carbon atoms — a grouping which, by itself, has the properties associated with a fairly heavy lubricating oil.

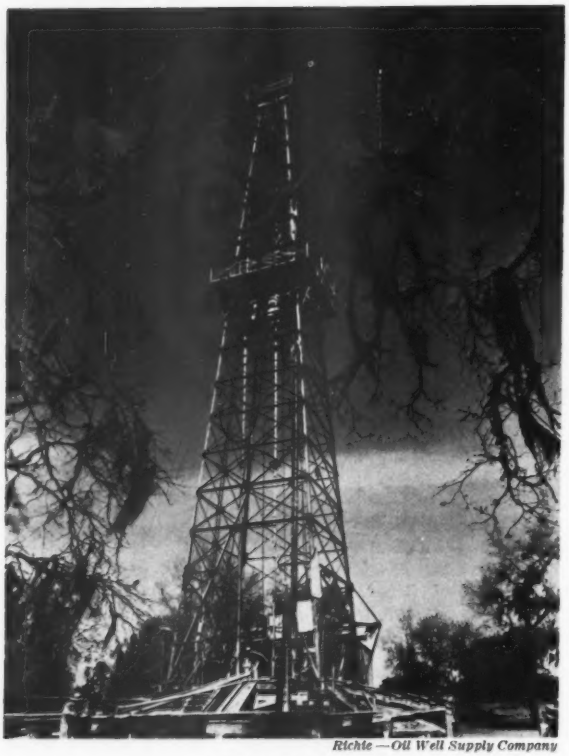
A soap solution brings water and grease into such intimate contact that the grease is emulsified and carried away; this is probably the best explanation, at present, for the detergent action of soap. Soap solutions, however, have another remarkable property: The soap reduces the surface tension of the water in which it is dissolved, thus causing the solution to wet substances more readily and to cling more firmly to their surfaces than does water alone. Hence soap is a wetting agent, as well as a detergent.

For many years chemists have recognized that Turkey-red oil — sulphonated castor oil — must be used if alizarin is to be applied successfully for the dyeing of Turkey red. While it is now certain that the sulphonated castor oil functions as a wetting agent, the matter has not attracted particular attention, although the practice has been regarded as an empirical necessity for good results. Wetting agents are by no means new, but the term is new, as is the term, penetrants, suggesting another use to which the material may be put.

During the past three or four years, wetting agents have become very prominent. Many of them are available commercially; many more have been studied and patented. They are used in laundries, in the dyeing and tanning industries, in the washing of fruit, in medicine (where they impart an increased efficacy to antiseptic solutions), in tooth paste, in metalworking shops, and wherever it is desired to apply an aqueous solution quickly and completely to the surface of a material. Some wetting agents are detergents, but some are not. The two properties are not necessarily associated, nor can the detergency of soap solutions be explained as due to their wetness.

The properties of a wetting agent may be demonstrated strikingly by a simple experiment: Pieces of sail cloth or wads of cotton, for example, will ordinarily float on water for hours; when thrown onto water which contains a small amount of wetting agent, they sink immediately. A drop of water on a smooth surface of paraffin stands up in the form of an almost spherical globule; the water makes an angle of 115 degrees with the paraffin. If the sodium salt of a fatty acid containing two, four, six, eight, and so on, carbon atoms is dissolved in the water, no considerable change in the angle which the water makes with the paraffin is apparent until acids containing more than eight carbon atoms are used. With an increase beyond eight, the angle decreases rapidly. A hundredth-formal solution of the sodium salt containing 14 carbon atoms makes an angle of only about 15 degrees with the paraffin surface. A hundredth-formal solution of sodium stearate (18 carbon atoms) might be expected to make almost no angle at all and, hence, to spread out on the paraffin surface, wetting it perfectly, but this experiment could not be tried because such a solution of sodium stearate is a jelly at ordinary temperatures.

Several varieties of wetting agents are now available commercially. The sodium alkyl sulphates, in which the alkyl group is either a group like lauryl (12 carbon atoms), which is procurable from natural sources, or a forked chain (perhaps of 17 carbon atoms), which is produced by synthesis, are widely used as wetting agents.



Richte —Oil Well Supply Company

ROTARY RIG

Equipment used in drilling oil wells. The standing pipes, successfully screwed together, follow the drill as it bores downward. Record depths drilled to date have exceeded 13,000 feet

The same substances find use as hard-water soaps, for the calcium and magnesium salts of the alkyl sulphuric acids, unlike the corresponding salts of the ordinary soap acids, are soluble in water. Other wetting agents are the sodium salts of the sulphonated alkyl naphthalenes. These, like the sodium alkyl sulphates, owe their properties to the electronegative parts of their molecules. Other substances, like the alkylated ammonium and phosphonium salts, derive their power as wetting agents from the electropositive parts of their molecules. There are wetting agents for use in acid, in alkaline, and in neutral solutions.

Proverbially, things absorb water like a sponge and shed water like a duck. We have not heard whether sponges are endowed with their own natural wetting agents, but there is a tale of how science circumvented nature in the matter of the duck. A chemist, wondering concerning the effect of his wetting agents on a duck, put the duck into a tub of water in which a small amount of wetting agent had been dissolved. The poor duck, unable to swim, wallowed about and finally sank, until only its head remained above the water. This was an ignominious and unusual position for a duck to be in. The chemist, being a humanitarian, fearing lest the bird might have suffered a chill, invited the duck to dine with him and his family on the following evening. So it fell out. He was made fully at home and was served with applesauce and Burgundy. Everyone liked the duck, and the duck agreed with everyone. There is no other sequel to this history of the humanist and the wetting agent.

Figures in Plastics

NO self-respecting whaling skipper ever reached for his *telescope* when his mastheads yelled, "Thar she blows"; he grabbed his *glass*. Nor does even the most miserable of bookworms refer publicly to his glasses as spectacles. He knows, or should know, that the words glass and lens are, to all intents, synonymous and have become so by reason of the unchallenged position which glass maintained for ages as the only commercially practical raw material for the optical industry. Two years ago, the last phrase could have been couched in the present tense, but the ubiquitous science of substitution seems, in this field, to have scored an advance which is saved from being revolutionary by no more than a quarter wavelength of light.

Involved in this not quite definitely established revolution are some of the latest man-made molecules to achieve major industrial importance: the synthetic resins. Like glass, these substances may be regarded as supercooled liquids, are frequently thermoplastic (softening on heating), are — not so frequently — of a clearness and transparency barely equaled by glass, and occasionally surpass the latter in some optical properties. Unlike glass, however, they are all formed and worked at comparatively low temperatures. This blessing is accompanied by a tendency toward lack of certain obdurate virtues characteristic of the furnace product, namely, great resistance to weathering and chemical attack and supreme stability against aging and dimensional changes.

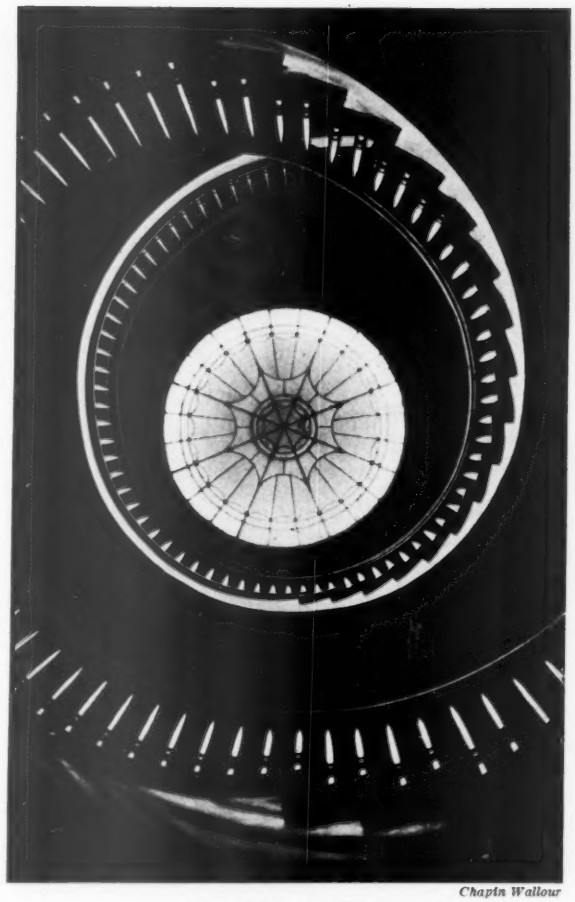
Chief of these products which most deserve to be called organic glasses are the various polymerized blood brothers of acrylic acid, known to the trade as Acryloid, Plexiglass, Lucite, and Perspex. The last substance is a methyl methacrylate recently developed by the Imperial Chemical Industries of England and now being molded by a process developed by Arthur W. Kingston and Peter Koch de Gooreynd (both Englishmen) into lenses claimed to be suitable for spectacles, cameras, opera glasses, binoculars, telescopes, range finders, optical systems for television apparatus, and scientific instruments.

Molding, while certainly far from a new method for shaping glass, is employed in the optical industry mainly in the preliminary forming of spectacle lenses. Grinding has always been the characteristic technique, a process so delicate and painfully slow that it is by tradition a trade for philosophers. To produce finished, polished lenses with one stroke of a ram, therefore, means the elimination of much skilled labor and makes credible the drastic cuts in production costs reported for the method. Molding, furthermore, will produce television mirror drums and other optical systems of complicated shape as easily as the simplest lens — forgetting, of course, about the dies. And, in view of the importance of optical equipment in armaments, the inventors stress the value of the process to countries not equipped with an elaborate optical industry. (The British industry, incidentally, is small.)

A little prying into the optical industry will discover that there are two general classes of lenses produced — spectacle lenses and precision lenses. To the uninitiated, the method of distinguishing between the two seems a trifle absurd; it consists of determining whether or not the lens was polished with felt. Such polishing destroys the figure of the lens, and, for efficient operation, a figure is more vital to a lens than to a chorus girl. This figure is the shape or curvature of the lens surface and for precise work cannot be departed from by more than one-quarter of a wavelength of light, which translates itself into a tolerance of plus or minus one two-hundred-thousandth inch. On a big telescope mirror, that tolerance shrinks almost to zero. To maintain such tolerances with a molded product means the production of molds which are just as accurate, and it is doubtful if a metal surface can take and keep an acceptable optical figure.

If the difficulty in evolving sufficiently accurate molding techniques is not enough to stop the spread of organic plastics into precise optical systems, there remain the problems of nonhomogeneity and dimensional stability.

While the best of the synthetic plastics can transmit up to 95 per cent of the visible light (or as much as optical glass) and up to 85 per cent of the available ultraviolet (or better than any glass), they are guilty of one of the blackest sins in precision optics — their index of refraction varies. The extreme impropriety of such nonhomogeneity is demonstrated by the slow and costly procedure resorted to by makers of optical glass in order to avoid it, and by the failure of the many excellent qualities of quartz to outweigh this same insufferable weakness.



Chapin Wallour

ELLIPTICAL HELIX

High lights on a unique stairway in Springfield, Mass.

Perhaps a lesser objection is the fact that plastics are plastic. Generally their greatest virtue, in precision optics it becomes a vice. Scientists fear that, over a long period of time, temperature variations, small but long-continued stresses, and possible subtle chemical changes may cause changes in shape beyond the permitted tolerances. Where large masses are concerned, the low heat conductivity and (compared to glass) high coefficient of expansion are not promising properties. On the other hand, the ease with which plastics may be scratched is a minor difficulty, for deterioration from this cause may be avoided by careful handling.

Even if this jaundiced point of view is correct, however, and plastics are to be forever barred from use in high-grade optical instruments, a wide and useful field remains. Completed lenses dropping from the presses at the rate of many thousand an hour certainly promise cheaper spectacles, cameras, and binoculars for popular use. In two fields, at least, the transparent plastics have already achieved dominance. As the nonshattering element in safety glass, their story needs no repeating here. It may be interesting to note, however, that molded airplane windows of cellulose acetate and acrylic resins have permitted streamlining effects otherwise extremely costly.

The All-American Canal, greatest ditch ever dug, stretches 80 miles from the Colorado River to the irrigated Imperial Valley

Ptz

The Million-Message Wave

TRANSMISSION of a million simultaneous telephone conversations, involving two million speakers, not in wire but in the familiar garden variety of downspout that commonly carries rain water from the roof to the ground, is one communication possibility being brought into the range of feasibility through research now under way. Feasibility, however, does not mean immediate application, for that must await the development of proper terminal equipment, particularly generators, modulators, and demodulators.

The communication pipe line is being developed by Dr. Wilmer L. Barrow, '29, of the Department of Electrical Engineering, who is following out some of the ramifications of the discovery of the transmissibility of ultra high-frequency radio waves through hollow conducting pipes. The Bell Telephone Laboratories and Dr. Barrow simultaneously published independent discoveries of this phenomenon in 1936 (see The Review, July, 1936, page 415).

The potentialities of this new way of transmitting messages offer interesting comparisons with the capabilities of more conventional methods. A hollow pipe conductor, two inches in diameter, has a potential capacity of transmitting a band of frequencies about ten billion cycles per second wide, and, therefore, of carrying one million simultaneous telephone conversations, each two-way conversation occupying two bands, each five thousand cycles broad, or two thousand television signals, each five million cycles broad. Local telephone wires, by contrast, carry a band only three thousand cycles per second in breadth; present open-wire, long-distance lines carry bands of only thirty thousand cycles per second; and the new New York–Philadelphia coaxial cable uses at present a band of one million cycles per second. Television requires a band of about five million cycles per second. In a copper pipe of two-inch diameter carrying two billion cycles per second, the rate of attenuation, or of decay of signal strength, is about the same as that in the New York–Philadelphia cable at a frequency only one-tenth as great, or two billion cycles per second. In the table below, the vital statistics of these various means of transmission are presented for ready comparison.

When they are sent through the conducting pipe, the ultra high-frequency waves may, according to one representation, be thought of as traveling in a zigzag course, bouncing from opposite sides of the pipe in sequence. Below what is called the critical frequency, the waves make an angle of 90 degrees with the walls of the pipe and, consequently, have no forward or longitudinal motion. They shoot back and forth across the pipe, perpendicularly to its walls, and the message which they embody does not get ahead. But raise the frequency slightly above this critical value and the angle at which the waves hit the sides of the pipe is decreased; their course, no longer perpendicular to the sides of the pipe, is in a zigzag path along it; the message moves. As the frequency is further increased, the angle of incidence is correspondingly lessened, the wave travels farther on each transverse jump, and the message moves faster.

This picture of the progress of the wave is one derived from Dr. Barrow's investigation of various types of waves in combination with various shapes of pipe, with a view to determining rates of attenuation. Series of different types of waves can be generated in the pipes, depending on the generating system used at the trans-

BAND WIDTHS OF SEVERAL COMMUNICATION MEANS

Conducting System and Service	*Band Width in cycles per sec.*	*Number of Simultaneous conversations, or channels*
Telegraph, direct open-wire line	100	1
Telephone, open-wire line and cable in local circuits	3,000	1
Telephone, open-wire carrier (present practice)	30,000	4
Telephone, open-wire carrier (projected system)	140,000	16
Telephone, coaxial cable (new New York–Philadelphia link) one coaxial unit	1,000,000	120
Television and telephone, coaxial cable, Germany	5,100,000	1
Television, 343-line picture (1936 experimental radio system)	5,200,000	1
Hollow pipe, two-inch diameter, potential capacity	10,000,000,000	1,000,000 telephone 2,000 television

MAR -3 1938

mitting end. For application to long-distance transmission, the round pipe seems the best; and, if excessively high frequencies are not available, a wave which has been labeled H_0 gives the lowest attenuation in a pipe of given size and cost. Of all the waves and all the pipe shapes tested, another wave, known as $H_{0,1}$, in a rectangular pipe, has the lowest critical frequency; also, it is the only one in which the electric lines of force are everywhere parallel to themselves. This last property has an especial value that will appear later.

Ordinary drainpipe, or downspout, came into the picture when Dr. Barrow set out to meet the criticism that hollow-pipe transmission would be difficult when it was necessary to turn corners. Hooking up sections of downspout and using the regulation elbows employed in connections to rain gutters, he has found that the waves will turn corners without trouble. The downspout was useful also in showing that gaps in the conductor can be jumped by the waves. When the sections of downspout were disconnected and their ends were placed an inch apart, the waves went on. As the opening is increased, of course, less power is transmitted.

The combination discussed presents powerful possibilities, but even these can be increased, for if different types of waves are used simultaneously, the range of a million telephone conversations or two thousand television channels may be doubled or tripled. The special property of $H_{0,1}$ which has been mentioned — the fact that in it the lines of electric force are everywhere parallel—gives to it, however, a peculiar importance. This quality of consistent parallelism means that this wave is properly lined up for radiation as a space wave, and that, if it is shot out of a tube whose end forms a horn, it gives a narrow radio beam, efficiently sharp and free from stray effects. Any undertaking that demands beam transmission of high directivity, then, may make good use of this combination. For applications to navigation on water and in air, in point-to-point radio communication, for direction finding, and perhaps in television, this property of the $H_{0,1}$ wave is a promising possibility.

The Chemistry of Cancer

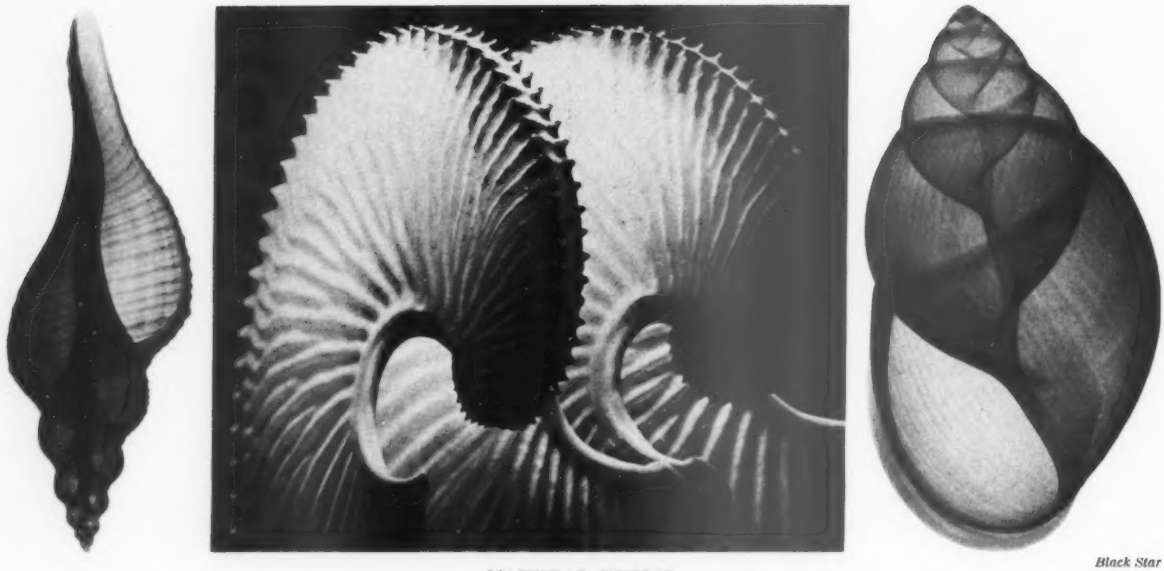
THAT the human body may itself produce chemicals giving rise to the cancer which may wreck it is one theory of the origin of the disease. This was given new statement by Dr. James Ewing of New York before the recent meeting of the Pan American Medical Association in Havana, with the prediction that "a considerable number of human cancers" will be found to originate through the action of natural chemicals which are produced by the body and which closely resemble coal tars. Normal body secretions, Dr. Ewing said, if they are excessive or are in slightly altered form, may cause the growth of malignant tumors. Secretions akin to the coal tars are the sex hormones, vitamins, and bile acids. Evidence exists, Dr. Ewing declared, to show that hormones are one of the factors leading to some forms of human cancer, especially those forms affecting the sex organs. Such altered or excessive hormones, however, must be aided by other factors, he said, before the cancer arises.

The theory had gained new supporting evidence a few weeks earlier, when Dr. Louis F. Fieser and his associates in the Converse Memorial Laboratory at Harvard made public a progress report on their study of cancer-producing compounds. Through the synthesizing of 68 new chemical compounds, 22 of which are definitely active in producing cancer, Dr. Fieser and his group have given researchers a more specific definition than ever of the structural peculiarities of carcinogenic chemicals. In addition, knowledge of some of the molecular characteristics important in producing growth of cancers is revealed by the study. The 68 new compounds synthesized resemble methylcholanthrene, the complex compound of hydrogen and carbon — very powerful as an agent of cancer — which Dr. Fieser produced synthetically three years ago. The new compounds differ slightly from it in the way in which their molecules are joined.

Methylcholanthrene can be obtained from the bile acids produced by the human body; this fact, Dr. Fieser declares, gives strong support to the possibility that abnormal physiological conditions leading to production within the body of a similar chemical may be a cause of cancer. The linking system of the molecules of the cancer-producing chemicals, moreover, closely resembles that of various chemicals naturally found in the body. This resemblance is now being studied in the hope that it may give light on the origin of cancer-producing chemicals. Direct experimental evidence of

AERODYNAMIC FORM
A study in functional beauty

Korth



Black Star

NATURAL FORMS

Left and right. *The x-ray reveals the delicate construction of shells.* Center. *The exquisite shell of the cuttlefish, the "ship of the Argonauts"*

the formation of these chemicals in the body has not yet been possible, so that this circumstantial evidence is the more valuable.

Light from the Abyss

A GOOD half of this planet's surface is buried under 10,000 feet or more of salt water. More remote in actuality than the face of the moon, the bottom of this vast abyss forms a *terra incognita* with features so unique that even the most desperate efforts of scientific fiction writers have failed to create imagery more grotesque than the facts already known. The abyss is a place of intense silence, of blackness streaked with phosphorescence, and of steady, numbing cold that does not vary a degree throughout the year. Weird forms part these dense waters, sometimes with immense eyes to catch the faintest gleam of a phosphorescent organ, sometimes with no eyes at all, but always with huge maws and elastic stomachs ready for the infrequent meals that interrupt their famine. From the upper reaches, a fine rain of dust and organic debris floats down, but little that is edible passes the gauntlet of finny scavengers. Even those skeletons composed of calcium carbonate are mainly dissolved in the last few miles of fall. No sailor ever reached Davy Jones's locker unless his bones were chromium plated.

Yet deposits accumulate, and over 51,500,000 square miles of the bottom are covered by one type of sediment alone, the famous red clays. Containing such odd substances as the ear bones of whales, the teeth of sharks, and the dust of stars, these substances were first studied by the *Challenger* expedition in the middle Seventies. The three-year voyage of this ship, although perhaps the greatest scientific journey ever attempted, did not explain the origin of these sediments — the most characteristic of the deep sea — nor did it measure the rate at which they were being laid down. The scientists weighed cosmic dust, classified the ear bones, and counted the sharks' teeth but deduced from their relative abundance merely that the rate of deposition was extremely slow.

Important if for no reason other than their startling magnitudes, the deep-sea deposits gain additional significance from their relation to the history of the ocean basins, the climates of the past, the cycle of life within the sea, and many another fundamental geological riddle. Modern sounders of the abyss have advanced somewhat beyond the technique of Captain Phipps, the first one on record whose curiosity led him, on September 4, 1773, to tie together all the sounding lines aboard his ship, coat his lead with tallow, and bring up from 683 fathoms (4,098 feet) a sample of soft, blue mud. Today's fisher-after-oozes has coring devices at his disposal, such as the "gun" developed by Carnegie Institution's Dr. Charles Piggot, which can bring up a complete cross section of the bottom to a depth of ten feet. To the gratification of scientists, such samples often show definite stratification.

It was in smaller but similar stratified samples, brought up from the deeps of the tropical Atlantic by the German research ship, *Meteor*, that W. B. Schott recently found, or thought he found, an important clue to the puzzles of earth science that are tied up with the ocean bottom. Close investigation convinced him that material from all sources was being laid down on the floors of the deep sea at the rate of approximately one centimeter every thousand years. Similar experiments in the Indian Ocean checked this figure.

Unfortunately, calculations based on this datum give absurdly gigantic thicknesses for the total amount of sediment. If one assumes, as does the Dutchman, P. H. Kuenen, that the deep seas have existed for 1,700,000,000 years, Schott's rate gives (*Concluded on page 232*)

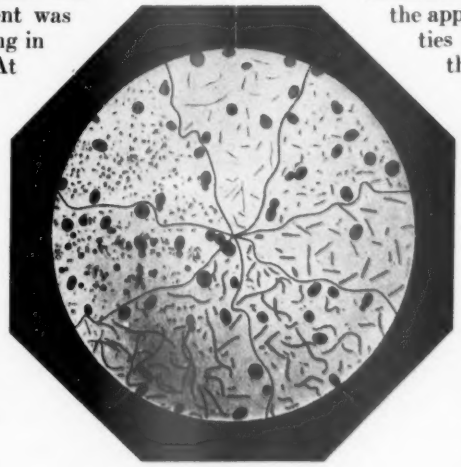
Putting Germs to Work

Harnessing Microbes for Man's Service

By Samuel C. Prescott

JUST about a hundred years ago, in the period between 1830 and 1855, numerous logical and carefully planned experiments were carried out, the results of which led to the conclusion that neither the life-giving influence of oxygen nor those fortuitous combinations of conditions which were earlier conceived to result in spontaneous generation were the cause of the development of those hosts of microbic life which swarmed in the rich food solutions employed, but that their development was the result of antecedent life existing in soil, air, and various materials. At about the same time, previous to 1850, yeast was proved to be a living plant and to be the probable cause rather than the result of the fermentations of beer and wine. It had likewise been made clear that mother of vinegar was a mass of living cells of uncertain classification, which could in some way transform wine into vinegar.

It remained, however, for the experiments of Helmholtz and especially the epoch-making work of Louis Pasteur to explain these phenomena. Pasteur, as a result of his discovery of the chemical change in racemic compounds by the action of fungi and his later magnificent studies on the deteriorations of wine and beer, not only proved that life without air is possible but also clearly established the germ theory of fermentation. This was the antecedent of, and supplied the basic principle on which was founded, the germ theory of disease, which he later elaborated and by which he is universally known. This great principle or discovery is often ranked as the most significant scientific development of the 19th Century. It is interesting to note, in passing, that it was an industrial research that led to this important truth which has been of such immeasurable benefit to human welfare.



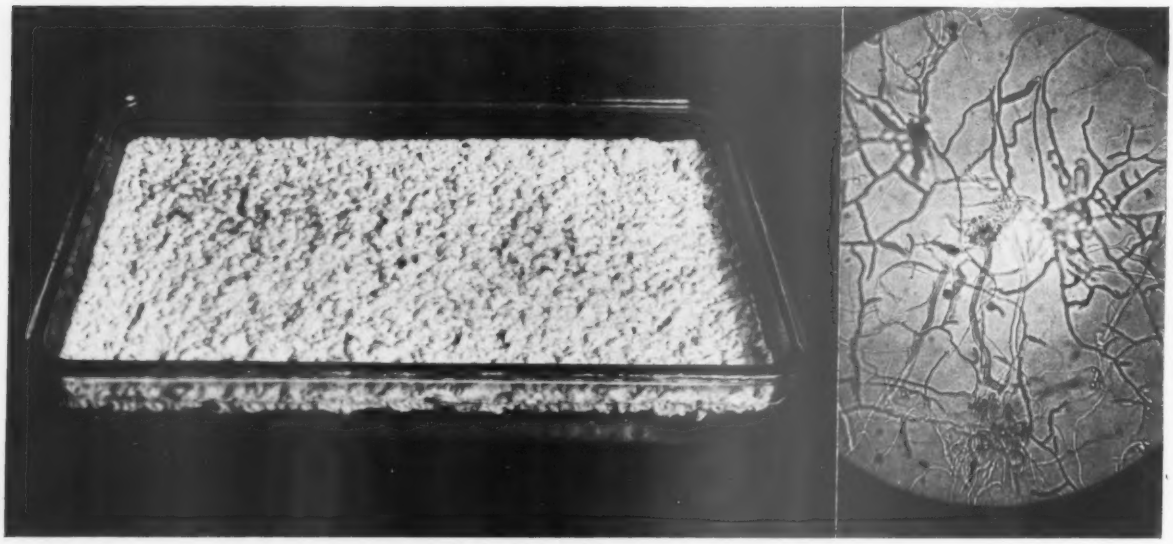
EPOCH MAKING

This photomicrograph dates back to Pasteur and shows the types of organisms he isolated in his studies of wine and beer. These studies established the germ theory of fermentation, and this industrial research supplied the basic principle on which was founded the germ theory of disease

Pasteur's persistent and laborious investigations concerning microörganisms, first in the field of fermentation and later in his investigation of the silkworm disease, not only twice saved France from financial ruin but greatly advanced wine, beer, and other fermentations, and undoubtedly preserved the silk industry of the world. The story of each of these industrial triumphs is a dramatic record of scientific achievement — of logic and vision, of patient research, of indomitable will. From the study of the silkworm disease came the foundations for the whole structure of preventive medicine, with its use of antitoxins, protective serums, and so on, and much of the basic principle of applied public health as we know it today. From the study of fermentations and the "diseases" of wine and beer developed the facts and theories which in more recent years have led to industrial processes of great interest and value.

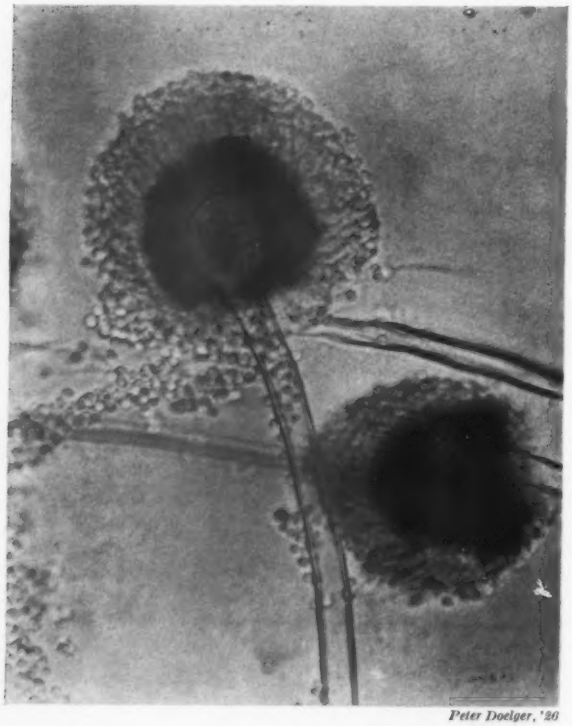
Industrial microbiology is concerned with the applications and relations of the activties of yeasts, molds, and bacteria to the production of desired materials or to economic processes. These applications and relations may be of opposing natures, for on the one hand, we seek to control and foster the utilization of microbic energy for the constructive purpose of producing useful and desirable materials as a result of fermentations, while on the other hand, we attempt to control and prevent the development of germs causative of harmful or destructive chemical processes, as, for example, in our methods of food preservation.

While certain fermentation industries, such as brewing and wine making, have been practiced with comparative success for hundreds or even thousands of years, it is obvious that the fundamental changes involved in these processes were not and could not be entirely understood. Nevertheless, the alcoholic fermentation produced by yeast not only was, but still remains, the most important fermentation industry. There is, however, a considerable list of other microbic processes which may not be devoid of interest as examples of putting germs to work in a productive manner. Ability to do this centers in three facts: The first is that under suitable conditions of substrate and environment, each type of usable organism produces a specific fermentation, with definite types of chemical changes, just as each type of pathogenic microbe produces its specific, characteristic disease under the same circumstances. The second fact of importance lies in the speed with which microbes can reproduce or develop, when placed under favorable conditions. A single bacterium, for example, which reproduces by the simple process of breaking in two and in which the generation time may be even less than 30 minutes, would, if its growth rate continued unchecked by its own products,



A. NIGER: THREE PORTRAITS

Nearly all the commercial citric acid used today in soft drinks, foods such as certain soups, and for technical uses in chemistry is now produced by molds. At the left is one of these molds, Aspergillus niger, *growing in a shallow dish, and at the right is a magnified picture of the fungus, showing the beginnings of spore formation. Below is* A. niger *in the act of budding (throwing off new spores)*



Peter Doelger, '20

multiply in 15 hours to something over a billion organisms, or to about 268 trillion in 24 hours. Incidentally, if the microbe were of ordinary size, such a number would be easily compressed into a cube with an edge of one-quarter inch. A third factor of significance is that the living cell carries on its work without the application of great external energy, such as the use of extremely high temperature, vast consumption of electric current, or great pressure — factors which are often necessary to bring about the same kind of chemical change by the use of purely chemical methods.

While in most instances one makes use of a single kind of microbe, it is possible that several organisms may be employed, each doing a particular part of the work. Probably future developments in fermentation industries will take advantage of these microbic alliances or successions, as the case may be.

Putting germs to work under factory conditions is, therefore, but an imitation of natural processes, carried out under intensive and controlled conditions. In theory we simply supply the materials and the conditions which observation or experiment teaches us will be of greatest advantage. In practice it is not so easy.

Probably the best known of all the processes utilizing microbes as agents of chemical or biological activity are the industries in which yeasts are the organisms supplying the motive power. It is not always recognized that the yeast, which is present to the extent of some eight billion living cells or plants in an ordinary yeast cake, is but one of many scores of species of microörganisms with wide distribution in nature.

Of the many which are now known, one genus of yeasts, the Saccharomyces, with a few species, has been of great industrial importance for untold years. It includes the organisms responsible for the production of our usual forms of bread, for the preparation of beer and ale, for the fermentation of cider and wines, and for the fermentation which precedes distillation in the manufacture of industrial alcohol and in the production of strong liquors, such as whisky and rum. These processes have been known so long that it is not necessary to explain them in detail. It may be of interest, however, to mention that the type of yeast which is employed in making beer is slightly different from that used for ale, and that a distillery yeast or a bakery yeast is also a

specially cultivated strain. In early days the fermentations were all spontaneous or brought about without reference to purity of culture, by the simple expedient of carrying over a little of the deposit from a fermenting mass into the next batch of material to be fermented. With wines the situation is somewhat different, for the grapes used have their own special types of yeast, which live on their surfaces, waiting only for the grapes to be crushed in order to begin their action on the sugary juice inclosed.

Since the days of the work of Pasteur, it has been known that such fermentations might go awry because of the contamination with undesirable species. About 60 years ago a Dane named Hansen developed a new technique for the cultivation of brewery yeast by isolating a single individual cell and causing that to grow in a sterilized medium until the requisite quantity needed for a particular purpose had been produced. This is commonly done in many Continental European breweries and in a few places in America. The procedure cannot be exactly followed with wines since the fruit juices are changed in taste and quality by heat sterilization, but the general result can be accomplished by growing a culture of the desired yeast and adding that to the juice at the beginning of the fermentation process, thereby greatly outnumbering the questionable or undesirable organisms which might naturally be present on the fruit. The competition is thus rendered unequal and greatly in favor of the desired types.

There are many instances in which the alcoholic fermentation is carried out solely for the production of industrial alcohol of high purity and not for beverage purposes. Here again yeast is of great importance, and certain types of yeast have been developed which are particularly effective, for yeast can, to some degree, be "trained" by specialized cultivation. Moreover, since there are many substances in nature which can yield sugar by either microbic or chemical treatment, our raw materials are not confined to fruit juices, molasses, or malt extracts, but may include wood fiber, sawdust, or even hay or straw as potential sources. The use of any particular material is largely a matter of economics of treatment as well as of microbic adaptability.

There are, however, many interesting things about yeast, other than its ability to ferment sugars. It is in itself so rich in food materials and accessory substances or vitamins that it is grown and used in great quantity for feeding purposes. All have doubtless read (and doubted) the advertisements for Vitamin D milk. The claims are often extreme but are not entirely false. Yeast grown on suitable culture media has the power to synthesize Vitamin D, and cows fed on special rations in which yeast is an important component thus ingest and later transfer to their milk some of this important vitamin, the special function of which is to prevent rickets, a disease that develops when the sunlight is not rich enough in the actinic rays which produce the vitamin in green grass or in the animal body exposed to sunlight directly. Here it should also be mentioned that yeast cultures constitute the principal source of supply of the commercial Vitamin D now used quite extensively.

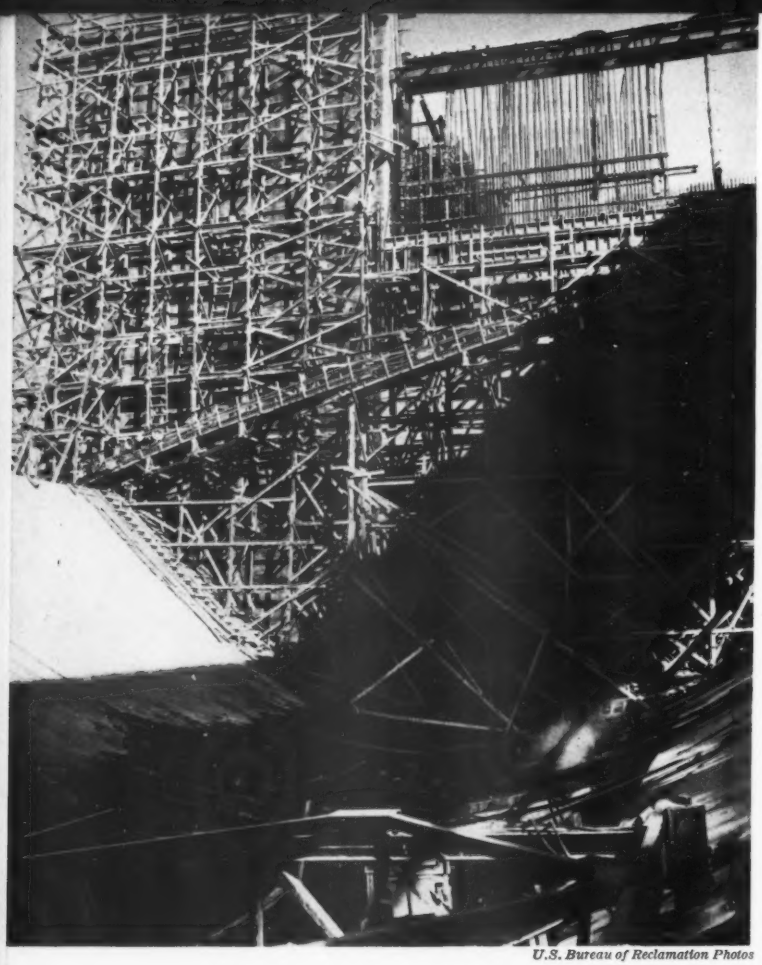
A few years go it was observed that actively growing yeast and fungi can also store in their cells and deposit between their cells small masses of fat. Under ordinary conditions this might have no special significance, but it became of great significance in Germany when, during the War, she was cut off from the usual sources of fats and oils, and her own fat-producing animals were decimated, as they had to be killed off for food purposes for the soldiers and the civil population. No figures are obtainable, but I have firsthand information from German bacteriologists that the quantity of fat produced in this way was considerable, and that after extracting it the yeast was then used for animal food in large quantities. Pure yeast can also be used as the source of foods, corresponding to beef extracts for soups and broths, by digesting it with pepsin and then concentrating the digested mass to the consistency of paste. A number of such products are made, but they are not of much commercial significance at the present time. Nevertheless, all these processes have greatly increased yeast production as a business.

For a number of years, yeast has been used as a food material for cattle and other domestic animals under the name of fodder yeast. Recently the production of one of these cattle foods has been accomplished by the activity of a budding, yeastlike fungus, *Torula utilis*, which will grow rapidly in solutions of wood sugar to which mineral salts or malt germ has been added to supply the necessary nitrogen, with the result that yeast amounting to 40 per cent of the weight of sugar fermented can be obtained.

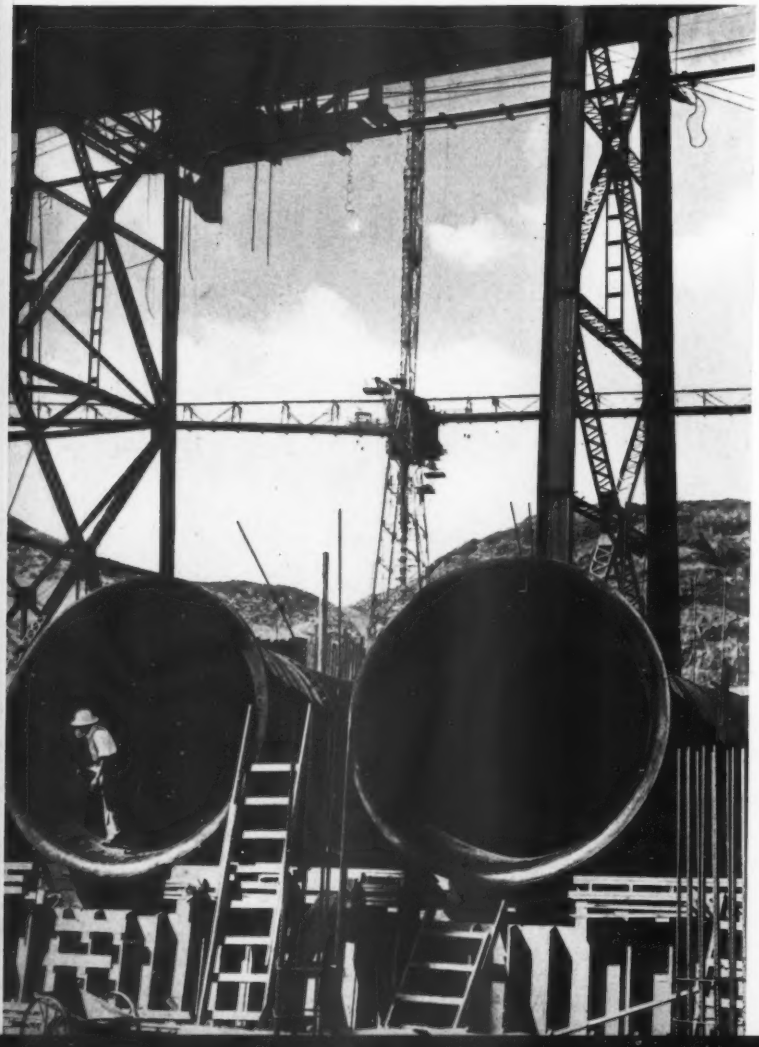
When Pasteur carried out his painstaking studies on wine and beer, about the time of our Civil War, he made the discovery that in addition to the change from sugar to alcohol and carbon dioxide which yeast brings about, there were small quantities of other products which he was able to detect by most careful analysis. One of these was succinic acid; another was glycerin. This observation, later confirmed by others, (*Continued on page 234*)

PRODUCING ALCOHOL

Fungus (mold) growing in a limited supply of air, showing its method of budding for forming new cells



U.S. Bureau of Reclamation Photos



GO west 90 miles from Spokane, metropolis of a self-styled Inland Empire which claims all the eastern half of the state of Washington, and you will stand on the floor of an immense, dry, flat-bottomed valley which is 52 miles long and from one and a half to five miles wide. This is the Grand Coulee, through which the Columbia River in a prehistoric period coursed a majestic southerly

passage on its way toward the sea, confined between banks which now are the precipitous cliffs, at times a thousand feet high, bounding the valley. We know it was a mighty waterway, for near the lower end of the valley are what we call the Dry Falls, the remains of a cataract greater than any other. There the three-mile width of the Columbia poured over a 400-foot escarpment, in a waterfall five times as broad and two and a half times as high as the Niagara of our day.

Theory has it that the Grand Coulee was an unnatural channel, cut by the river itself when its normal gorge was blocked during the last great Ice Age; that, when the ice sheet receded, the river reverted to its original bed where it has since remained. This explains why the arid shelf of the Upper Coulee cuts off abruptly where it intersects the south wall of the present valley of the Columbia. The edge at this junction hangs 500 feet

Hail Columbia!

Grand Coulee Enters the Final Phase

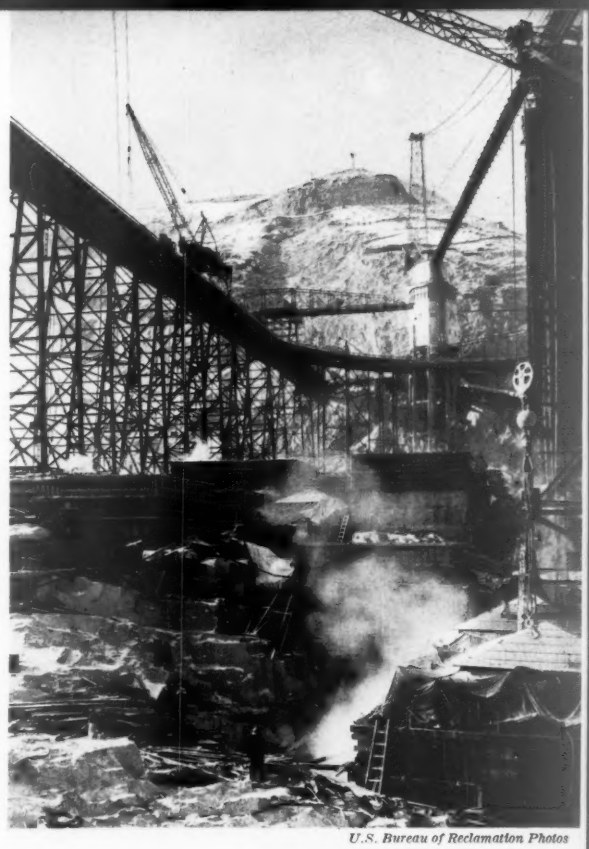
above the present surface of the water, and during the past five years it has been a vantage point from which to observe the activities of an army of workers often numbering as many as six thousand. By the use of steel and concrete they are building a barrier to replace the prehistoric one of ice which melted away, and when they are done waters from the Columbia will again pass through the Grand Coulee. That is why they have selected Grand Coulee for the name of the *permanent* dam.

Behind all this effort stands as a main purpose provision for irrigation of some 1,200,000 acres of southeastern Washington, an area almost as large as that of Delaware. But the dam will also serve to regulate the flow of the Columbia and to develop electric energy to be used in pumping for irrigation and for other needs, while still further considerations involved are those of flood control and the improvement of navigation.

This is the most costly and elaborate engineering project ever undertaken by man, and the final bill will run twenty-five million dollars higher than that of the Panama Canal. The first contract, which has just been completed, involved the placing of 4,520,312 cubic yards of concrete; the final contract, which now has begun and is to bring the dam to its ultimate height of 550 feet above bedrock, calls for 5,250,000 cubic feet more—which means a total three times

that needed to complete Boulder Dam, or enough to pave a two-strip standard highway from New York to San Francisco. In all, 80,000 tons of steel will be required, while up to now the contractors have used 75,000,000 board feet of lumber for forms and other purposes. Grand Coulee's ultimate horsepower will be half again more than Boulder Dam's and almost four times that of the Russian Dnepropetrovsk.

Behind the massive 550-foot wall, which is to have a crest length of 4,300 feet, there will be impounded a reservoir, 151 miles long, which will hold sufficient water to supply the equivalent of a good-sized swimming pool to every *third* man, woman, and child in the United States. Ordinarily, the water in this storage reservoir will be about 350 feet above the river level, and pumps will raise it about 280 feet more to a balancing reservoir which is to be formed by two auxiliary dams, 23 miles apart, laid across the Grand Coulee itself. From this balancing reservoir, which will have a maximum capacity of over one million acre-feet, water will flow by gravity to the fortunate lands it is destined to bless.



U.S. Bureau of Reclamation Photos

The Chemist in the Cathedral

Here in this solemn vault, remote, whose vast
Seclusive spaces contradict the bounds
Of mind, let me, reflective, be alone
And still.
Around,
In moving stone and glowing glass, presses
In pageantry the creed of centuries.
In antique traceries as involuted
As the mystery informing them, the tendrils
Of the vine, the stout fruits of the oak
Infuse molding and capital with life.
Blood red and royal blue the common day
Assumes under the subtle alchemy
Of color and of craft combined to set
Doctor, saint, symbol, emblem, and the Sign
Duly about the focus of all awe,
The altar, inward nucleus of this cell,
Center of all these present orbits.
And
Of what others? For clearly have we come
To know that no reality is what
It seems; no symbol represents one self
Alone; no truth is known, finite, and fixed —
All is approximation. This we know
When from our every final certitude
Unknowns and variables rise to plague us.
And daily, too, we see each being be
Not what it is but symbol of another:
From chaos, cosmos rising into chaos;
From finitude, infinity engendered.
No, that which is, is only as it stands
A sign of something still beyond, unknown.
That being which this being symbolized
Is but a symbol too — and of what strange
Unknown we now no longer dare surmise.

To be a man is but to be
Forever on a verge of seeing,
Forever poised, expectant,
Wrung by the straining ecstasy
That springs from quivering cords of thought,
Cords stretched to limit of endurance
And, there, by the keen plectrum of "almost"
Plucked, until the taut string snaps.
To seek, to seek; never to find.

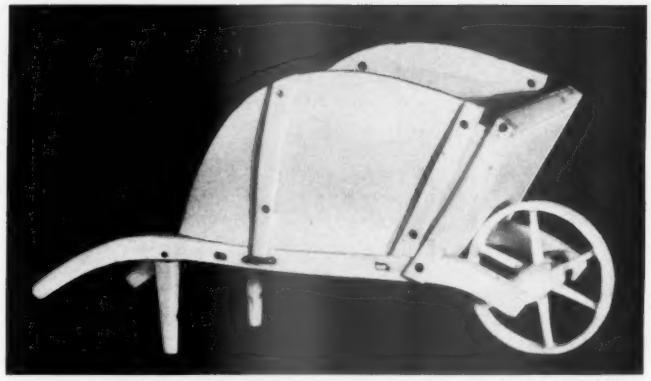
So being, then we must (perhaps to spite
Our impotence?) set up an answer, pay
It reverence, see it as whole and final —
So hush the doubt and free the soul for life
In here and now — until forth springs the question
New-guised again to fret us.
Nor does one creed
One age suffice, one formula succeed —
Too great the matter is, too varied men.
Consider but this mighty fabric, whose base
Bears down the very earth, whose arches soar
High and heavenward, insolent of failure,
Buttressed and bold, whose spires stab the sky —
And all a symbol of strength, finality,
The last great certitude; it must be this.

So they who built it must have dreamed —
How else through fivescore years
Engross the sweat, the horny skin
Of hands, the gold, the thought?

Precursors not of me, but what I seem,
Were heretic to this, ignored the Rose,
Turned from the Lamb, nor raised their eyes in awe
As towers soared to exalt humility.
Forsworn all they. Benevolent alembic,
And mystic number, and tetragon supreme,
Elixir, stone of wise men, stars, powers,
Demons, and fiends as well — to these they bowed;
So stirred immiscibles, so pondered blunders —
And so in crystal mortars crushed eternally
The strange wild stuff of dreams under the mad
Unmastered pestle, Hope.
Too young, so old.
Too young they were. And we, so older, still
Too young.
But in this vault and in that dream
Somehow I sense a oneness. Crux and flux
Are here in me now for a moment met.
And in this architected crucible
That men once raised wherein to fuse the godly
Secret, and in that outer mystery
My archetype could not defeat, I see —
I see — What do I see!
Only that Form
Is Formlessness that strives back to itself —
Only that Man and all Man yearns are Form,
And Form the mask that Formlessness assumes,
So that the symbol now inclosing me
Still represents a hope of flux to find
Itself again; so that the urgent dream
That held the damned mind stretched, taut, wrung,
Then was — still is! — but crux, and that but flux
Somehow in agony.
And these calm stones,
Those furious hopes, are nothing in themselves;
How far soever sundered, they are one
In meaning: Slag upon a seething surge.
The surge alone imports.

FREDERICK G. FASSETT, JR.

M. I. T. Photo



WHALE "IVORY" WHEELBARROW
Out of lovesickness or loneliness . . .

Technology Photos

Scrimshaw—The Perfect Hobby

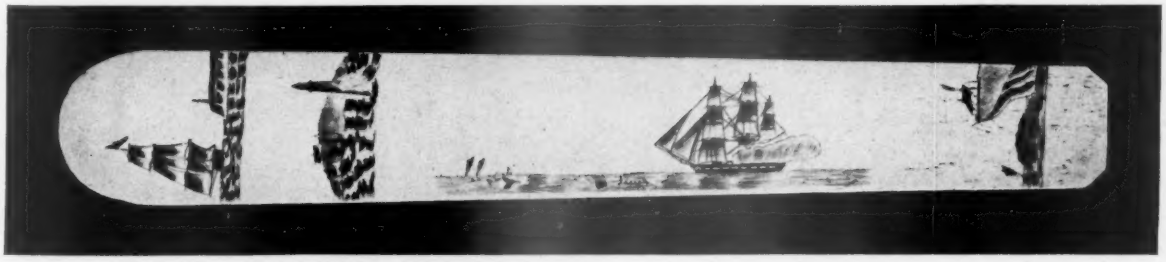
Whalemen Found It a Triumphant Answer to an Acute Problem

By Arthur C. Watson

THE splendid loan exhibit of the Henry P. Kendall whaling collection, now to be seen in M.I.T.'s Nautical Museum, has many phases. Perhaps the most interesting and unusual is that of the scrimshaw — the trinkets made by the whalemen out of whale ivory, jawbone, and whalebone. No story of leisure, of hobbies, or of folk art would be complete without its chapter on scrimshaw, for this artistic effort was begot by the most soul-shattering monotony known to industrial pursuits; it was a triumphant answer to an acute problem. Hence, scrimshaw is of particular interest at the present time when so much is being said and written about the problem of man's leisure.

Though the significance of scrimshaw becomes apparent only when we look into the forecastle of the old-time whaler and note the routine of life, yet the outward aspects of American whaling may serve as a frame for that picture. The industry swept onward with meteoric grandeur from the close of the War of 1812 to the Civil War and the coming of petroleum. When the industry was at its height, more than seven hundred whaleships were sailing from the ports of southeastern New England, outnumbering those from all the rest of the world. The annual value of the catch was averaging over ten million dollars. The whale was furnishing the world's supply of illuminating and of lubricating oil. The New Bedford shipowners built themselves palaces of dressed granite with Grecian colonnades. The circle of the oceans was their horizon. Their courageous captains were exploring the uncharted seas of Polynesia, penetrating the Okhotsk and the Arctic, often venturing where no sail had ever been before. Their ships would bring them back the oil — the wealth — and also many marvelous mementos of conquest — the giant tortoise from the Galápagos, the night-blooming cereus from Honolulu, the war club from the Marquesas.

The glories of whaling during the 1840's and the 1850's depended not only upon the enterprise of the owner and the courage of the captain; there was the all-important man power, the vast tribe of the forecastle. This power was recruited in a manner that would seem almost incredible to a modern personnel director. Only a few shipped with their eyes open, and these were youths with fair promise of a career. The rest came from the back-country farms, lured by deceitful broadsides, or from the spider webs of the New York shipping



SCRIMSHAW VERSION OF THE BODICE STAY OR BUSK

"This bone once in a sperm whale's jaw did rest
Now 'tis intended for a woman's brest.
This, my love, I do intend
For you to wear and not to lend."

SENTIMENT . . . SKILL . . . PATIENCE . . . PRIDE

. . . went into the whaleman's scrimshaw; sentiment, for example, as engraved on the adjacent tooth (not to mention the busk on the preceding page), skill as exemplified by the two jagging wheels (for crimping the edges of pies), patience by the intricacy of the handsome swift on the opposite page, and pride in a dangerous profession by the remarkable cane on page 224.

These pieces of scrimshaw are but a few of those in the Henry P. Kendall whaling collection at M.I.T., opened to the public last December as a part of the Nautical Museum

agents — the so-called land sharks — or from jails whence they were bailed by the outfitters. To these were added negroes, mulattoes, Portuguese from the Azores and the Cape Verdes. In one respect, this promiscuity was inevitable. During the great upswing, the industry had outstripped its means; the fast-increasing number of ships launched and purchased for whaling and the equally fast-growing crafts such as boatbuilding, ropemaking, and rigging were draining the population of the ports; it was impossible to continue the days when all-Yankee crews were easily obtained.

And while the boom was affecting the personnel of the forecastle, it had its influence also in the cabin. Even New England, nurse of all that is the best in the maritime character, could not produce, sufficiently fast, men of that peculiar combination of qualities that reigns well on the quarter-deck. While some captains who were "fathers to their men" still existed, the general efficiency tended to decrease. But that made little difference. Give the ship her quota of the best boats that human craft could build, give her the finest of cordage, give her discipline of iron — and the oil would come home.

The system, then, was opposed to a healthy harmony aboard ship. So was the nature of the cruises. A whaling voyage, particularly one around the Horn, generally lasted at least three years. This long period was split into passages, visits to various ports for supplies, and cruises. The cruise was the period spent on some whaling ground. Cruises varied somewhat in their character. There were grounds on which life was very exciting, like the bowhead regions of the North Pacific, especially in the early years of the fishery there, when boats were lowered almost every day, and the brisk air and the good luck thrilled the whalemen. But the typical cruise, like one on a much-used sperm-whaling ground of the temperate Pacific, was the breeder of bad blood. Six or eight months of idly zigzagging about, with the lookout at masthead drowsing, and the men and officers on deck fretting.

The ebbing spirit of the long cruise has often been described in whaling literature, but no better indications can be found than those thoroughly spontaneous thoughts confided to the seamen's own journals. I have collected many such excerpts and arrange a few here:

See cock petrel — a sign of sperm whales. . . .

Misfortunes comes from Heaven
And why should we complain
For we have done our best endeavour
A cargo to obtain. . . .

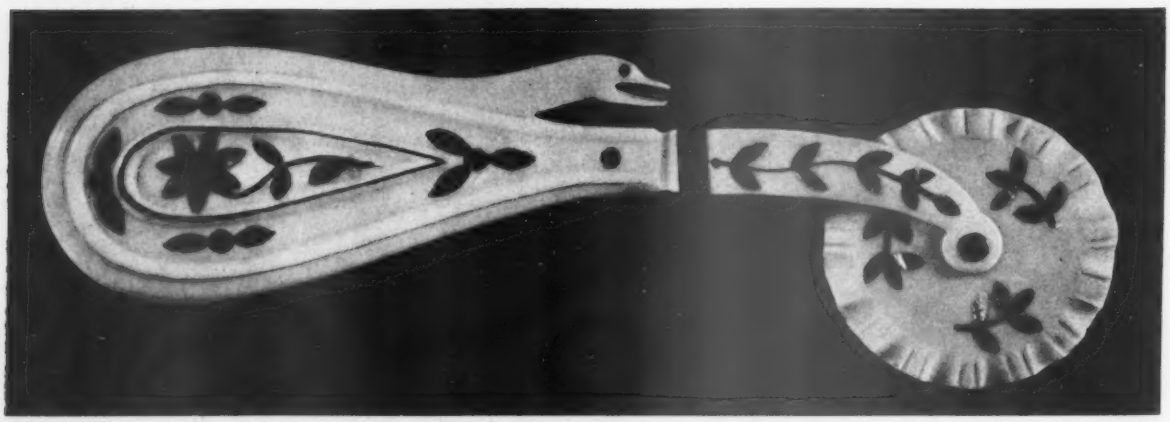
Right phase of the moon for whales. . . .

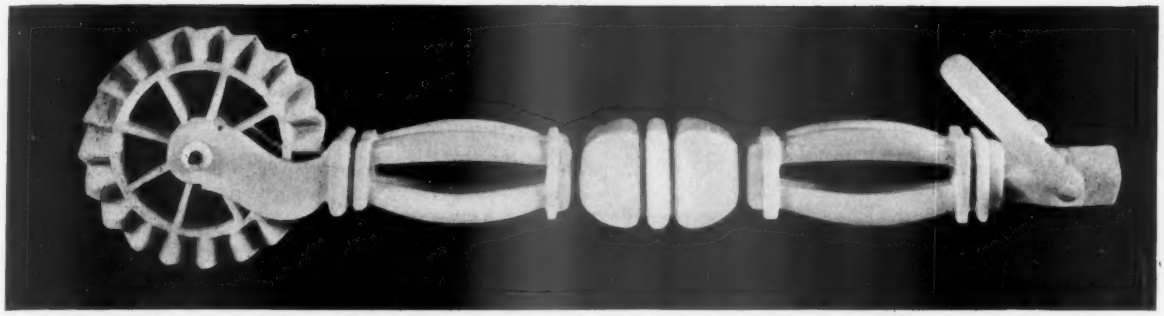
We are sailing,
We ain't whaling. . . .

The mast-heads are all asleep. . . . See finbacks — a sign of sperm whales. . . . Reading old letters to find something new. . . . Nothing to do but look at each other. . . .

o lord look down upon us hear
and touch our hearts with humble fear
from vain desirs o set us free
and give us peas and unitey . . .

Nothing to do but build air castles. . . . No whales . . . The people at home don't pray. . . . Plenty of rats aboard,





cockroaches and bed-bugs. . . . At dinner-time not much to do but eat. . . . Talking is out of fashion. . . . Cook says there was a row in the cabin. . . .

A whale at last . . . Cut in . . . Tried out . . . But nobody around to see the smoke. . . .

And now the whales have all left the ground. . . . Dry times . . . Dry times. . . .

Dull prospects all around us,
Large families behind. . . .

About as cheerless as standing on the Fairhaven bridge on a cold winter's night, waiting for some one to lose his pocket-book so that you can find it and get a reward. . . .

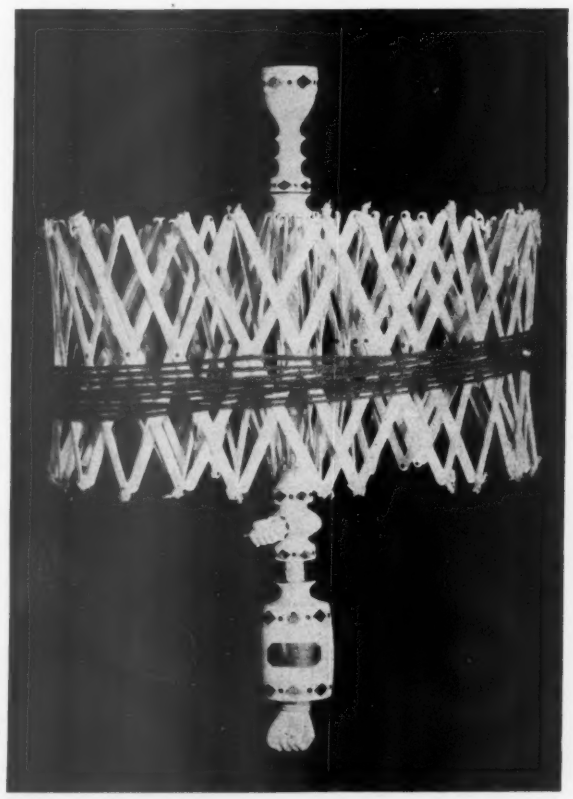
Ugly faces aft this morning. . . . Made little whales out of wood and threw them overboard to attract the whales. . . . See bull dolphin — a sure sign of whales. . . . See a large snake on the water, supposed to be a sea serpent. . . . Catch a shark, pull out his insides, heart and all, to see how long he'll keep flipping. . . .

Writing letters home. . . . Dear Friends Parents I should like to Pass the day with You to day but it is not so for me to do I should like To hear from you all as I have not since i sailed O Hannah P Ingalls if you and all the rest of you new how I longed to se you I think you would rite a line To A Poor disconsolate chap. . . .

Just as the tiny sea life on the surface of the ocean rots in a calm, so human life rotted on the long, dry cruise. "Just think of it," writes one seaman, "to be penned up and tossed about on the wide ocean for I suppose the space of three years . . . then see if you can think strange that sailors live fast what little time they stay on shore."

The whale chase itself — and the anticipation of it — was one relief from monotony. Though the chase was the most perilous of all hunts, men who had been ill would leap enthusiastically from their berths at the sound of "Thar Blows!" The catching of a whale meant money and success for the voyage, it is true; but there was a joy in it, too, that is hard to explain. When green hands went on to a whale for the first time, they were apt to be terrorized, even jumping from the boat at a glimpse of the animal. For this reason, green hands were ordered never to turn their heads as they were rowing in the chase, and men have been struck severely by their mate for disobedience. Yet the experienced whaleman was without fear, and it is possible that the shabbiness of his routine had much to do with it. Now his only other escape from the ills of monotony was invented for the whaleman by himself. This escape was his scrimshaw, the perfect hobby, into which went his sentiment, his skill, his patience, and his pride. The term "scrimshaw" includes any article, made by the handicraft of a seaman, in which some material from the whale is used. The material might be the tooth of the sperm whale, or the jawbone of the same animal, or the whalebone of some other species. The last-named (as those who are acquainted with the whale know) is a sort of cartilaginous material, occurring in long and narrow slabs which droop from the upper jaw like a comb and which are used as a strainer during the feeding process. Along with the tooth, the jawbone, or the whalebone, the artist might use some tropical wood, mother-of-pearl, tortoise shell, or coconut shell.

Articles of scrimshaw covered a wide range. First were the engravings — on polished teeth, on slabs of bone or whalebone. And then there were the carvings,



generally out of the ivory. These included jagging wheels for crimping the edges of pies, cane handles, handles for coconut-shell dippers, and any number of objects of individual fancy. There were round baskets made of steamed bone, boxes with elaborate inlay, collapsible swifts or yarn reels, toys, knitting needles, rolling pins, spool racks, and candlesticks. I have seen a parrot cage with the bars of bone, and a clock-case supported by figurines in whale ivory. Scrimshaw broadens out to include many objects of utility made by the whalemen for use aboard ship, such as the fids, the blocks, and the serving mallets of bone. And I think even the artificial leg made out of a sperm whale's jaw for Captain Ahab of "Moby Dick" must be classified as scrimshaw.

From the foregoing list it becomes apparent that scrimshaw was, to a large extent, an outlet for the lovesickness and loneliness of many a seaman. By far the greater number of the trinkets must have been made with some wife or sweetheart — some "Hannah P. Ingalls" — in mind. On the busks or bodice stays made by the seamen out of whalebone or of jawbone are often found emblems of love engraved and an occasional verse like the following:

This bone once in a sperm whale's jaw did rest
Now 'tis intended for a woman's brest.
This, my love, I do intend,
For you to wear and not to lend.

From the old journals of the confidential type, one can often reconstruct a romance and sense the spirit in which many of the scrimshawed articles were created. The inner life of many a journal writer seems to have revolved about the letters from home. His entries would be jubilant when a ship was encountered bearing the world's most precious documents, and they would grow mournful and worried as long months passed without sight of sail. Romances moved very slowly in those days, and faiths were kept over the years of absence. Married couples took their separation in a matter-of-fact way. One captain, who was about to leave on a short North Atlantic voyage, was reminded by his mate that he had forgotten to kiss his wife. "Oh, I hadn't forgotten," he replied, "but we're only going to be gone ten months." The words "speed" and "machine age" were unknown. There is the story of the wife who wrote to her husband at sea, asking the whereabouts of the household hammer. Ten months later the answer came from the Pacific that the hammer must have dropped behind the grindstone in the shed. And five months later a letter arrived in the Pacific with the words, "I didn't mean the hammer. That was stupid of me. But where did you put the axe?"

It was the slowness of life, the mental lassitude of the long cruise that furnished the temper needed for lingering, painstaking work. The

sperm-whale's tooth, the "ivory" — true and beautiful material — was friendly only to the most patient workman and made the most highly prized scrimshaw. The tooth, in its natural state, was smooth only at the tip; below, where it had been covered by the gum, it was roughly ribbed. The whaleman, in preparing a tooth for engraving, first used a coarse, handmade file to scrape off the ribs; then, a finer file to work it down, while the bands of the ivory colors began to appear and disappear; then, sandpaper — or a piece of sharkskin; and at length, pumice, if he were fortunate, or ashes from the tryworks. But the final polish was from the palm of the hand, for then only would come the softness which, with the peculiar warmth, is known to no other material but ivory. All this had to be done slowly, and each stage completed before the next could be commenced, for the workman did not depend upon sandpaper to eliminate the coarse file cuts, or upon his palm to do more than it could.

Now the sharp, pointed instrument — a sail needle in a bone handle, perhaps — had to make the design under meticulous control. A surface of ever-varying curvatures — a different direction of pressure for every direction of line and for every infinite segment of line. A slip — and the entire engraving might have to be filed out and one side of the tooth resmoothed. Surely there were times when even the unhurried whaleman might have regretted his elaborate conception of design long before he reached the moment when he could work the India ink or the "gunk and gurry" into the striations and begin the final palming.

The whalemen had many tricks in their art. They would often soak the tooth in brine to give the ivory an orange richness. If the tooth had dried and lost its original softness, they would dip it in hot water for easier tooling. In engraving they would often paste a picture on the tooth and prick out the design, joining the points afterwards. There were many stock types in the repertoire of the tooth engravers — Godey ladies, Lincolns and Napoleons, little dramas like the "Sailor's Return," willow trees overhanging tombstones, and so on. But the teeth most favored by collectors today are those engraved freehand — ships and whaling scenes, the rare attempts at family portraiture.

A second use of the ivory was in carving, and it was in this technique that the scrimshaw artist generally showed himself at his best. Handles for canes, handles for coconut-shell dippers, and jagging wheels were produced in large numbers. The last-named were the real masterpieces of scrimshaw, as anyone who has examined the delicacy of the small wheels with their fluted edges will admit. Occasionally one comes across an ivory carving of striking originality and workmanship. The Kendall collection has two such pieces that (*Continued on page 245*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

When Good Fellows Get Together

SHORTLY after this Review reaches its readers, the gun will be fired to start an important Technology race. March 7 has been set by the Alumni Fund Committee as the date for the beginning of the All-Technology Regional Contest which closes on midnight of March 28. During these three March weeks, men in every region of Technology's far-flung Alumni Empire will vie with one another in demonstrating their loyalty to the Institute and their endorsement of the all-alumni project to build the man as well as the mind.

For contest purposes the nation has been divided into seven districts, each district subdivided into regions so conceived as to afford every region a chance to win its district crown. From the contest, therefore, will emerge seven district winners. To each subscriber in each winning region will be presented a replica of one of Technology's oldest steins, as tangible evidence of his own contribution to victory. To the chairmen of the three winning regions which have outstanding records, there will be the further reward of a trip to, and honors on, Alumni Day, next June 6. Finally, as kudos for posterity to note, a plaque listing the winning regions will be installed in the new gymnasium.

Though the bars go down on March 7, everything accomplished since the beginning of the campaign last October will be counted. It is, therefore, possible to point out some probable front runners in advance of the start. At the moment, the leaders are as follows: in District 1, Chicago, with Pittsburgh and Detroit neck and neck and not far behind, followed by New York, Newark, and Philadelphia, while Boston, Washington, and the Californian cities bring up the rear; in District 2, Wilmington, leading the whole nation, pressed by Schenectady, Rochester, and Niagara Falls, all of whom show better than regional leaders in other districts; in District 3, Akron, with the closest contests afforded by Cleveland, Toledo, Dayton, and St. Louis; in District 4, Vermont; in District 5, North Carolina and Knoxville; in District 6, Montana; in District 7, Oklahoma, with El Paso's hot breath on her neck. In every district, every region has a chance, despite the starting advantage enjoyed by those mentioned, and there is every prospect of an exciting and amusing parade to the finish line.

The Alumni Fund Committee intends to conduct this contest with a strong undercurrent of good feeling. No effort has been spared to make sure that in the month of March each Technology Alumnus shall have opportunity to meet a fellow Alumnus face to face and to express his opinion about the Alumni Fund with check, pledge, or otherwise. On the other hand, it is being equally stressed that Technology measures no man's loyalty in terms of his money contribution, that the whole question at issue is whether or not good fellows are, in fact, ready to get together. If they are, there can be no question of the result.

Already the message is being carried to Alumni everywhere that the time to subscribe is now, and that this opportunity will not knock forever. They are being urged to give a rouse in the Marchtime, to let life and their fountain pens slip tether, to prove, as the singer sang, that the good-fellowship of Technology knows no bad weather — in short, to grasp the opportunity provided by this contest. That opportunity is best expressed by the stimulating words which will accompany every mailing piece from now to journey's end: "Build Yourself Into Tech."

The Meaning of Friends

THE Friends of the M. I. T. Library have made a notable contribution to the Eastman Library in the gift of a great collection of spectroscopic literature from the famous scientific library of Professor Heinrich Kayser, the distinguished and now aged German physicist and dean of world spectroscopists. This unsurpassed library, which recently arrived from Bonn University where Professor Kayser lives in retirement, includes approximately one hundred volumes on spectros-

AS TROPHIES

. . . replicas of this old Technology stein will be presented to every subscriber in every region which leads its district in the March All-Technology Regional Contest staged by the Alumni Fund Committee (see above)

HAVE YOU CONTRIBUTED YET?

YOU PROBABLY HAVE, BUT IF YOU HAVEN'T HERE IS A PORTRAIT (SLIGHTLY ON THE SUBCONSCIOUS SIDE) OF YOURSELF IN THE ACT OF REMEMBERING TO DO SO TODAY SO THAT YOU CAN HELP YOUR REGION WIN IN THE ALL-TECHNOLOGY ALUMNI FUND CONTEST.

MUTE THE HORNS OF THE DILEMMA THAT ARE SOUNDING OUTSIDE YOUR WINDOW AND CLEAR YOUR DESK OF THAT STACK OF PLEDGE CARDS BY FILLING OUT ONE AMPLY AND LEGIBLY. THEN AND THEN ONLY WILL YOU FEEL LIKE CROONING, "FOR IT'S ALWAYS FAIR WEATHER, ETC."

EMPHASIZING "WE ARE HAPPY", NOT "TECH IS HELL"

Published as one of a series of communications addressed to Alumni by the Fund Committee

copy and more than five thousand reprints of articles published in technical journals and sent to Professor Kayser to form an international clearing house of spectroscopic information. Some of the articles go back to the 1860's, and the collection covers the most active period in the advance of spectroscopy when, with its aid, physics, astronomy, and chemistry were revolutionized, and medicine, biology, and metallurgy greatly affected.

Professor Kayser, now 85 years old, has had a long and fruitful life at Bonn University. He is the author of several standard encyclopedic works on spectroscopy, and his "Handbuch der Spectroscopie," published in eight volumes, is probably referred to in spectroscopic literature more often than any other work. Despite his advanced age he has just completed a monumental autobiography.

The Kayser collection has special significance for the Institute's spectroscopic staff, for under the direction of Professor George R. Harrison this group has for several years been carrying on an extensive program of determination of the wavelengths of the spectral lines of the chemical elements. This research is a logical extension of that which Professor Kayser and his collaborators have been working on for many years.

Camp Technology

PROPERLY qualified students taking any course at the Institute, as well as selected students of high scholastic standing in civil engineering from other colleges and engineering schools, will be admitted next July to Camp Technology, in Maine, the summer surveying school of the Institute's Department of Civil and Sanitary Engineering. The new plan, which was recently approved by the Corporation, opens one of the finest engineering field camps in the country to students who never before have had the opportunity to take the Institute's summer surveying course. To those Technology students who are not studying civil engineering, the summer course offers the advantage of broadening their general education by intensive field experience of a type which is useful in almost any branch of business or industry. To students in colleges which do not maintain engineering camps of their own, the field work at Camp Technology applies in actual practice the theories and methods studied in purely academic courses of preparation. The tuition fee for the seven weeks, including subsistence, has been reduced to $100, the only additional expense being transportation to and from the camp.

The course, which begins late in July, includes field practice in the use and adjustment of surveying instruments, plane and topographic surveying, astronomical observations, hydrographic surveying, which includes stream gauging, drafting and map making from field notes, recitations, and lectures. There is also geodetic surveying, including the establishment of base lines and comprehensive triangulation systems. The instructing staff is composed of leading members of the Faculty of the Department of Civil and Sanitary Engineering. The Newark College of Engineering and the University of New Hampshire have already notified the Institute they will send students to the camp this summer, and other eastern colleges have indicated their interest in this coöperative plan of sharing unexcelled facilities.

HOBBY SHOP

Students have responded with enthusiasm to the provision, by the Institute, of shop facilities for recreational use (see below)

Camp Technology is situated eight miles from East Machias, Maine, and only a few miles from the sea. It stands on an 850-acre tract of forest and rolling hills, which affords every territorial condition necessary for effective instruction in the various methods of surveying. The buildings stand on a bluff high above Gardner's Lake, one of the most beautiful in northeastern Maine, and include Bemis Hall — a large recreation center for students, containing also a store, a post office, and the administrative offices. Adjacent to it are buildings with drafting and recitation rooms and lecture halls. The student sleeping quarters are in comfortable, one-story barracks overlooking the lake, with near-by facilities for swimming. There is also a large recreation field with tennis courts, and students have opportunities for boating and week-end camping and fishing trips to near-by lakes and streams. The staff has separate quarters, and there is a well-equipped infirmary with a physician in charge throughout the period of the camp.

In the Interest of Hobbies

THOSE who have hobbies of their own and know the peculiar pleasure and relaxation they bring, will realize the possibilities that lie in the well-equipped workshop just opened by the Institute for the use of its students. This wholesome contribution to the modern movement for the better use of leisure and the development of interesting and useful avocations was established in the belief that hobbies may be considered part of a well-rounded education. The new student workshop is a recreational facility in which intelligent craftsmanship will be encouraged. It will appeal particularly to those students of inventive or creative ability who up to now have had, at the Institute, no free outlet in that direction.

The shop is equipped with the usual hand tools for woodworking and metalworking, as well as a circular saw, jointer, grindstone, emery wheel, jig saw, drill press, wood and engine lathes, and sander. Later, if the demand arises, facilities for photography, electroplating, metal spinning, and other hobbies may be added.

Some of the equipment, such as workbenches, vises, and a few machines, were donated by various departments of the Institute, and a group of enthusiastic students did all the work of fitting out the shop. They built a lumber loft and have refinished all benches, installed cabinets, tool racks, and shelves. By an arrangement of countershafts, they are able to use one motor for several machines, and they have shown considerable ingenuity in designing supplementary fittings for various operations.

The possibilities of the shop are hinted in the work already under way. Several students are building miniature aircraft engines; another is busy on a new type of slide rule of his own design. Two others have ship models planned, while another is working on some secret invention. A number of students have asked to be assigned specific projects and they will be given the interesting task of building objects for the Institute's rapidly expanding museum of science and industry. In fact, one student is already at work on the reproduction of an ancient loom which will be added to the exhibit that shows the evolution of textile machinery.

The student workshop is the outgrowth of an idea that has been under consideration for several years. A survey in the autumn of 1934 indicated a lively hobby activity in the freshman class, and there was evidence that many students in the upper classes were interested. Freshman hobby shows were held on Open House Days in 1935 and 1936, and it is quite likely that the stimulus of the new shop will result in an even larger exhibit at this year's Open House, scheduled for April 30.

Arthur C. Watson (see page 221), who is in active charge of the development of the museum, is directing the work of the hobby shop. As former assistant curator of the New Bedford Whaling Museum, he is himself skilled in the design and construction of models, and his hand-carved scale models of the various species of whale is convincing evidence of the fact.

Harold Stein

SOLE PRESIDENTIAL NOMINEE

. . . for the Alumni Association, 1938–1939, H. B. Richmond, '14, Treasurer of General Radio Company, Cambridge. Associated with his present company since 1919, Mr. Richmond is widely known as an electrical engineer. He is a fellow of the Institute of Radio Engineers and a past president of the Radio Manufacturers Association. He is also a member of the American Institute of Electrical Engineers. As a member of the Alumni Council since 1919, he has served on the national nominating committee, on the committee on historical collections, and is a member of the Alumni Association's executive committee

Appointment

DOUGLASS VINCENT BROWN, who since 1933 has been assistant professor of medical economics in the Harvard Medical School, has been appointed assistant professor of industrial relations in the Department of Economics and Social Science at the Institute. Well qualified by training and interest to assist in the study of employer-employee relations, Dr. Brown will devote himself principally to the activities of the Institute's Industrial Relations Section, which was established recently for research and training in the field of industrial relations.

Dr. Brown is a graduate of Harvard University, having received his bachelor's degree in 1925 and his master's degree in arts a year later. In 1926 he held the Henry Lee Memorial Fellowship and a year later was awarded a Sheldon Travelling Fellowship. He was appointed an instructor in the department of economics of Harvard University in 1929 and three years later was promoted to the rank of assistant professor in the economics division of the Harvard Medical School.

The Coming Elections

VOTING for officers to represent the great alumni body of the Institute is a privilege and a responsibility which comes to all Alumni once a year. The National Nominating Committee — which this year included J. Lloyd Wayne, 3d, '96, Redfield Proctor, '02, Franklin O. Adams, '07, Edward L. Moreland, '07, Albert E. Wiggin, '07, Donald N. Frazier, '11, Frederick W. Barker, '12, Charles H. Chatfield, '14, Rolfe A. Folsom, '18, and Alfred T. Glassett, '20 — presents the following slate on the ballot now going in the mails to 30,000 Alumni.

President of the Alumni Association, H. B. Richmond, '14, VI, General Radio Company. *Vice-President*, Raymond Stevens, '17, XV, Arthur D. Little, Inc. *Executive Committee:* Hovey T. Freeman, '16, II, Manufacturers Mutual Fire Insurance Company; Edwin D. Ryer, '20, VI, Barbour Stockwell Company. *Representatives at Large on the Alumni Council:* Van Rensselaer Lansingh, '98, VI, Molybdenum Corporation of America; Theodore B. Parker, '11, I, Engineer; Jerome C. Hunsaker, '12, XIII-A, Department of Mechanical Engineering; Winfield I. McNeill, '17, XV, Colgate-Palmolive-Peet Company; Eric F. Hodgins, '22, X, *Fortune Magazine*.

Blank-Stoller, Inc. Noetzel Bachrach

ALUMNI NOMINEES

. . . for term membership on the Technology Corporation (left to right): Harry P. Charlesworth, '05, Assistant Chief Engineer of the American Telephone and Telegraph Company; Donald G. Robbins, '07, Secretary, Comptroller, and Director of the International Braid Company of Providence, R. I.; Marshall B. Dalton, '15, President of the Boston Manufacturers Mutual Fire Insurance Company, as well as the Paper Mill Mutual Insurance Company of Boston, and retiring President of the Alumni Association

In addition to the foregoing officers of the Association, the Committee presents nominations for term membership on the Institute's governing body, the *Corporation*. For the three vacancies this year the candidates are: Harry P. Charlesworth, '05, VI, American Telephone and Telegraph Company; Donald G. Robbins, '07, II, International Braid Company; Marshall B. Dalton, '15, I, Boston Manufacturers Mutual Fire Insurance Company.

Members of the National Nominating Committee are elected by districts, and the terms are staggered so that only a third of the body changes at one time. Since this year we lose Messrs. Adams, Folsom, and Wiggin, Districts 8, 9, and 10 — the districts they have served — are represented by the following nominees from whom the Alumni elect one for each district: *District 8:* Charles A. Smith, '99, I, Georgia Power Company; Donald W. Southgate, '11, IV, Architect; William J. Sherry, '21, X, William J. Sherry, Inc. *District 9:* Charles F. Willis, '06, III, *The Mining Journal;* George M. Gadsby, '09, V, Utah Power and Light Company; Hiram E. Beebe, '10, VI, The Beebe Company, Investments and Real Estate. *District 10:* Ernest B. MacNaughton, '02, IV, First National Bank of Portland, Ore.; William C. Furer, '06, IV, Architect; John C. Kinnear, '07, III, Nevada Consolidated Copper Company.

New Field Station

THE School of Chemical Engineering Practice of the Department of Chemical Engineering will soon open a new field station in the plant of the Hercules Powder Company at Parlin, N. J., where excellent facilities are available for the study of chemical engineering principles in plant operations. These include catalytic oxidation of ammonia to produce synthetic nitric acid, vacuum concentration of sulphuric acid, chlorination of rubber to produce a synthetic plastic used in the manufacture of corrosion-resistant paint, and many other operations, including the production of nitrocellulose and the concentration of alcohols by distillation.

The new station will be housed in a specially designed building now being constructed by the Hercules Powder Company for the use of the Institute's staff and students. This will include an office, combined laboratory and shop, and a library and large conference room. The Practice School is operated under the direction of Professor Walter G. Whitman, '17, Head of the Department, and the staff of the new station will include Robert C. Gunness, '34, as director, and James G. Baker, '36, as assistant director. Both were formerly on the staff of the Boston station of the School, which has been discontinued and relocated in the new situation.

The student enrollment of the School is normally between 45 and 60 men a year, and is divided into several smaller groups which attend each station for a two-month period. Groups studying at Parlin will live together in special quarters at Brunswick, N. J., a few miles from the plant.

197th Meeting

B. ALDEN THRESHER, '20, the Institute's Director of Admissions, was the guest and principal speaker at the regular monthly meeting of the Alumni Council on January 31. In describing the policies and procedures now being followed to determine the 600 successful candidates who will constitute the Institute's Class of 1942 when it matriculates next autumn, he spoke appreciatively of the part played in their selection by the Alumni.

Applicants are now judged upon a basis which includes a consideration of their nonacademic qualities, as well as their grades. This means, as Professor

Thresher emphasized, that correspondence alone will not suffice. On the contrary, each applicant is required to have an interview with an Institute representative, and, since well over half of the candidates are from points outside New England, it is obvious that the Faculty Committee on Admissions depends upon reports furnished by Honorary Secretaries and officers of alumni clubs.

Following Professor Thresher's remarks, the Council also enjoyed a showing of a remarkable colored cinematic record of yachting, including sequences made aboard J Class contenders which participated in last summer's competition for the America's Cup. The man who made this film, Frank H. Conant of the Institute's Photographic Service, added to its interest by contributing a voice accompaniment which explained some of the more technical details involved.

During the business session, J. E. Burchard, '23, Vice-Chairman of the Alumni Fund Campaign, spoke on its current condition; and H. B. Richmond, '14, President elect of the Alumni Association for 1938–1939 (see page 228), reported for the Committee on Historical Collections.

Foreseeing that the removal of the School of Architecture from the Rogers Building on Boylston Street, Boston, during the coming summer would mean that no Institute building would bear the name of the Institute's founder, the Committee recommended that "the Alumni Council suggest to the Corporation that it consider the advisability of designating the entrance unit of the main educational group now under erection on Massachusetts Avenue as the Rogers Building." This recommendation the Council endorsed by a unanimous vote.

It was decided to omit the regular February meeting in view of the Boston alumni smoker scheduled for the 24th, thus leaving three evenings remaining on the 1937–1938 program: March 28, April 25, and May 23, which last, by an interesting coincidence, will be the Council's 200th.

Public Health

A NEW course in public-health education, designed to train professional workers in one of the most important fields of the general public-health problem, began with the opening of the second term of the school year last month. The course is in charge of Professor Clair E. Turner, '17, of the Department of Biology and Public Health. His conviction is that if the public can be trained in the proper care of health, dietary-deficiency diseases and many infectious diseases will be virtually eliminated.

The purpose of the new course is to teach professional public-health workers the technique, scope, and methods of health education, as well as its relation to the general health problem. Professor Turner believes that education in this field must not only train public-health officials how to avoid disease and safeguard the public in general but must attack the fundamental problem of teaching the average citizen how he, as an individual, can avoid disease.

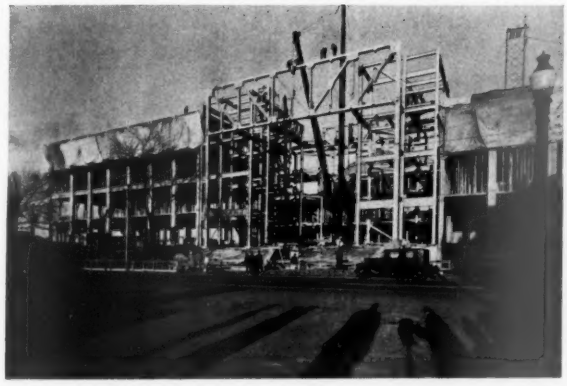
The methods and techniques employed in public-health instruction which will be considered in the course include the press, radio, motion pictures, lectures, exhibits, reports, personal contacts, and community campaigns. A number of graduate students from the Institute and from the Harvard School of Public Health are registered in this course, which is open also to properly qualified public-health workers.

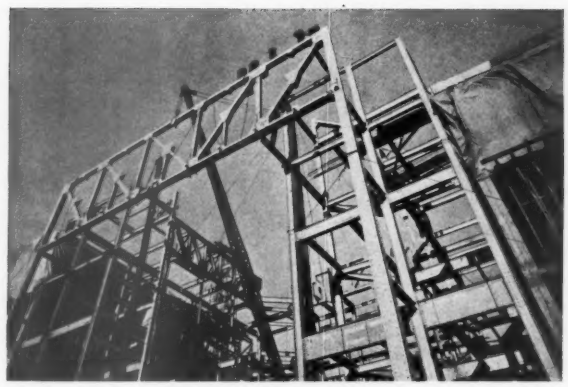
Harry W. Tyler, 1863–1938

IN the death of Harry W. Tyler, '84, Emeritus Professor of Mathematics and former Head of the Department of Mathematics, on February 3, the Institute lost not only an Alumnus whose loyalty was best expressed by his unfailing interest in the advancement of Technology, but one whose distinguished career as a member of the Faculty was an inseparable component of its history for 46 years. Dr. Tyler was born in Ips-

TIN HAT

The high-voltage, or nuclear, research laboratory strikes a new note in the Cambridge sky line. The Van de Graaff generator stands under the welded "derby hat"





INNER GRACE

The steel and concrete structure of the rising Architecture Building has a dramatic beauty of its own. The steel supports the dome

wich, Mass., and died in Washington, D. C., in his 75th year, after an illness of a few hours. Mrs. Tyler, as will be recalled, died last November.

Gifted as a speaker and endowed with a sense of humor both whimsical and penetrating, Dr. Tyler will long be remembered by all who knew the pleasure of his delightful talks and his witty introduction of guests on the frequent occasions at which he presided. They will remember him as a man of medium stature, with full, gray hair, and a generous beard, who spoke in a deep, rich voice with words of great preciseness. They will recall, too, that when he arose to speak he would place widespread finger tips upon the table, lean forward with eyes twinkling over his spectacles, begin his talk with a deliberative, "Ah, Gentlemen," and a series of little coughs.

A brilliant student, but never a grind, Dr. Tyler found time in his undergraduate days to participate in student activities, and in his senior year he was president of the board of directors of *The Tech*, which was then but three years old. Among the students in the Course in Chemistry in which he was studying was Miss Alice Brown, who later became Mrs. Tyler. Their marriage, soon after they were graduated, marked the beginning of a long and happy companionship of united interests and high ideals. Their summers for many years were spent on the shores of Lake Winnepesaukee in New Hampshire, where Dr. Tyler had ample opportunity to indulge in his hobby of mountaineering, which later led to his election as president of the Appalachian Mountain Club. With them in those years were their four daughters: Dr. Margaret Tyler of New Haven, Conn.; Mrs. Wallace H. Walcott of Scarsdale, N. Y.; Mrs. J. H. Phillips of Flushing, N. Y.; and Mrs. Stafford Johnson of Cambridge, Mass.

After his graduation, Dr. Tyler was an instructor in mathematics at the Institute for three years and then, having been granted leave of absence, spent two years abroad in travel and study. He carried on advanced work at Göttingen, and at Erlangen completed the requirements for his doctorate of philosophy. Returning to the Institute, he began a career of great activity and steadily increasing influence. In 1890, at the age of 27, he was appointed an assistant professor of mathematics, and in three years had reached the rank of professor. Soon after his appointment in 1901 as head of the Department of Mathematics, which he administered with such distinction until his retirement in 1930, he was appointed to the chair of Walker Professor of Mathematics.

Throughout these years Dr. Tyler found time outside his departmental duties to take an important part in the development of the Institute's administrative and academic policies. Prior to 1906 he was for 15 years secretary of the Faculty, a position which in those days combined the duties of dean, registrar, and assistant to President Walker. His unwavering faith in the future of the Institute prompted him to oppose vigorously the proposed merger of Technology with Harvard. When at last the fight had been won, he entered more zealously than ever into the affairs of the Institute, which at that time was passing through a serious financial crisis. His sound judgment and vision contributed importantly to M.I.T.'s subsequent steady development and the growth of its prestige. In 1913 he became chairman of the Faculty, a position in which for two years he helped to shape Technology's academic course. During this period and thereafter, he served on many important faculty committees. He was also president of the Faculty Club from its founding until his retirement.

Dr. Tyler was chairman of the Walker Memorial Committee and led the successful campaign for a building devoted entirely to student activities. His concern for the welfare and broad development of students was indicated anew by his active interest in the present campaign for the greater student recreation center, and as president of the Washington Society of the M.I.T. and chairman of its campaign committee, he had energetically supported it. Last year, Dr. and Mrs. Tyler established the Alice Brown Tyler Fund, the income of which is to be used for the welfare of women students at Technology.

As one of the founders of the College Entrance Board examination system in 1901, Dr. Tyler was always active in its affairs and was vice-chairman of the board at the time he retired from the Institute in 1930. When he moved to Washington he devoted himself to the American Association of University Professors, of which he was a former vice-president and until recently acting general secretary. Meantime, he was consultant on scientific literature to the Library of Congress.

HARRY WALTER TYLER, 1863–1938

The portrait of the late Professor Emeritus, painted by Isaac B. Hazelton, '94, and presented to the Institute on Alumni Day, 1936

On Alumni Day in June, 1936, a portrait of Dr. Tyler was presented to the Institute by a group of his friends on the Corporation, the Faculty, and among his former students. Happily, Dr. Tyler was present to hear the address of presentation by Dean Samuel C. Prescott, '94, and to reply humorously that he congratulated the committee, the artist (Isaac B. Hazelton, '94), and the Institute on the possession of a portrait which "I should be proud to have at any time resembled — let us say as a first approximation."

House Master

WALTER C. WOOD, '17, who, as sailing master of the M.I.T. Nautical Association, is well known among the students and members of the staff, has been appointed master of the Senior House, which will occupy the quarters of the Graduate House after that group moves to Riverbank Court next autumn.

Mr. Wood, who will become master of the Senior House with the opening of the academic year next September, is head of the Narragansett Yacht Fittings Company and is widely known as a designer of special equipment for yachts, as well as for his ability as a racing skipper. He has long been active in the popularization of small-boat racing. The rapidly growing interest in the sport among college groups and Technology's leadership in dinghy sailing are due in no small degree to his knowledge of sailing and his ability as an instructor. During the World War, Mr. Wood was an instructor in the Army aviation school at Technology and later became chief of instruction at Arcadia, Fla.

THE TREND OF AFFAIRS

(*Concluded from page 214*)

a layer of deposits over more than one-half the earth's area, which layer is about 10 miles thick and would require for its formation the erosion of a layer about 20 miles deep from the continents — more than most geologists will admit possible. To aggravate this discrepancy, Kuenen points out that very little of the material eroded from the continents ever reaches the deep sea, the vast bulk of such debris settling on the continental shelves. Only the finest wind- and sea-borne dust ever reaches the abyss. According to the Dutch oceanographer, the rate is really about one-third Schott's figure, and he estimates that the square kilometer of volcanic material which he believes is being extruded onto the ocean bottom yearly would, if spread out evenly, form a layer 1/3,000 centimeter thick. What is more, says Kuenen, Schott's data really check this figure surprisingly well, for the *Meteor* samples contained 70 per cent of water by volume, indicating that the time needed to deposit one centimeter of *solid* material is 3,300 years and not 1,000.

Kuenen argues further that the present rate is probably a fair average for all time (geologists' and not sporting writers' time), for in the very earliest periods, when the lime-secreting planktonic organisms were not so prevalent as today, there was far more erosion of continents not yet effectively protected by plant life and that similar compensations existed in extremely humid or unusually dry eras.

Another correction which must be attempted before the thickness of deposits is arrived at is the effect of compaction. Since there is little evidence to show how sediments will behave when laid down under a pressure of 7,000 pounds, or so, to the square inch, it was assumed that they settle much as in shallow water. On that basis the original floor of the permanent seas is covered by about three miles of sediment. A random examination of the problems affected by this condition discloses that the temperature of the earth below this blanket of colored mud should be 200 degrees C. higher and the crystalline crust about three miles thinner. This ooze also interferes seriously with Wegener's theory of continental drift.

To an observer too ignorant to follow the hard reasoning and savage checking that lead from a simple measurement to pronouncements on the fate of worlds, the whole affair takes on a tinge of mystery, even drama. An explorer on a lonely front of science drops a plummet into the depths of the sea and drags up a handful of mud from which he squeezes a philosopher's stone. Another scholar, from another country, finds the cutting false, and by judiciously mixing pure logic with a strong dose of judgment (did the Delphian oracles do far otherwise?), learns how to reshape the facets. With light thus brought from the abyss, a whole series of problems related (in the layman's eyes) only by their huge dimensions and vast displacement in time, are brought into the focus of understanding. Considering the public's confidence in science which, as far as it is concerned, is mainly so established, one may speak of the Scientific faith as one does of the Christian.

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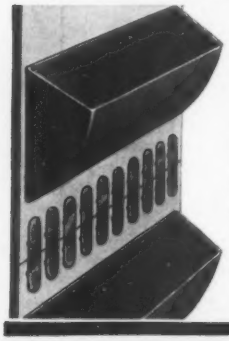

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PUTTING GERMS TO WORK

(*Continued from page 217*)

remained merely as an interesting fact for a half century. Glycerin was well known as a by-product of soap manufacture, and this source is ordinarily ample to meet the normal needs for this commodity. With the development of nitroglycerin as a high explosive for many purposes, especially during the War, soap factories were unable to supply the vast quantities desired by warring nations and makers of munitions. Prices soared to unheard of heights. Chemists sought new methods, but without great success. Germany, with a shortage of fats, was in distress, but as I have indicated, turned some of her distilleries into fat factories. These, however, were far from adequate to meet demands. Bacteriologists in several countries, possibly remembering the work of Pasteur, had already sought their yeast cultures, with the hope that here might lie success. And here it was found, for in 1916 or 1917 a hard-working young investigator in the Internal Revenue laboratory at Washington was rewarded by the discovery, patented in 1918, that when yeast is forced or trained to grow in sugar solutions having a suitable alkaline instead of an acid reaction, the decomposition of the sugar results in a smaller yield in alcohol but a considerably increased yield of glycerin — not the mere small percentage found by Pasteur as a maximum. The announcement stimulated research. By use of sodium sulphite to produce alkaline reaction, and by training the yeast to withstand high concentrations of this salt, the glycerin product was increased until it represented more than a third of the sugar fermented.

Production on a vast commercial scale was carried out at various places. With the cessation of hostilities and the normal supply from soapmaking, the industry ceased to be a profitable one, and little fermentation glycerin is now made. But the process is available when needed, and science gained greatly, for by the researches following the period of intensive production, much insight was gained into the complex reactions involved, and a new step was taken in the process of unlocking the secret of fermentation and the complex chemistry of the living cell. Undoubtedly numerous new secret fermentation processes have already been found which will have their devastating application in the next great war.

Another instance of putting germs to work is also, in a large degree, the outcome of the War, although it had its inception at an earlier time. The possibility of synthesizing rubber cheaply on a commercial scale had been for many years the dream problem of organic chemists, since the synthesis had actually been accomplished in the laboratory in 1860. This, therefore, may be regarded as the starting point. For such a synthesis, either isoprene or butadiene was required. The latter could be prepared from butyl alcohol, but unfortunately there was no cheap source of this reagent. The problem became more pressing with the great demand for rubber, first as a result of the bicycle and then, after 1900, when the automobile began to assume importance, before the great production of plantation rubber had met market requirements. Pasteur had found, about 1860, that butyl alcohol was produced in small quantities in certain microbic reactions, but with the (*Continued on page 236*)

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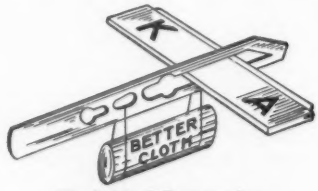

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PUTTING GERMS TO WORK

(*Continued from page 234*)

pressure of more important researches had not regarded it of special significance. However, with characteristic thoroughness he had recorded and published the fact. Others later supported and confirmed his findings.

Sometime in the Eighties an organism, *B. orthobutylicus*, was described by Fitz, but as new microbes were constantly being reported in that era, little attention was paid to it. Twenty years later, when the rubber shortage was becoming most acute, it was remembered, and a search for it or for new organisms was stimulated. This search was successful but not until too late to affect the rubber situation, for by 1903 plantation rubber from the new rubber-tree farms of the Straits Settlements, Java, and Sumatra had begun to be marketed and soon far outstripped the wild rubber from Brazil in quantity. Nevertheless, at least two bacteriologists persisted in the search for butyl alcohol producers. Of these, one was Chaim Weizmann, of whom all may have heard as the leader of the Zionist movement to recreate a new Jewish state in Palestine; the other was a worker named Fernbach at the Pasteur Institute in Paris. By 1915 each of the two men had discovered an organism which acted on starch or sugar, yielding small amounts of butyl alcohol mixed with acetone and ethyl alcohol. This was interesting but at the moment unimportant commercially.

The rediscovery was important, however, for by this time the World War had begun. New high explosives, recently developed, came into use, among them the British cordite, which required in its preparation not butyl alcohol but acetone. The airplane also came into use as a War engine. To prepare the dope used on the wings, a solvent was needed and acetone was the best. The old sources of acetone from acetates or by distillation of wood were vastly incapable of meeting the demand, and stupendous efforts were made to discover new processes and develop supplies or suitable substitutes. The new biological sources were made known, and fermentation was feverishly pursued. Acetone could be made by microbes! By 1916 some large plants were established in England. Two others were shortly started in Toronto, and soon after, an old distillery in Terre Haute, Ind., was converted into another. Others in Peoria, Ill., were being conditioned. In Wilmington, Del., the Du Ponts had already developed a new process. A somewhat similar fermentation had been worked out for using seaweeds, and near San Diego, great pits were developed in which giant kelps from the Pacific could be converted into acetone and alginic acid by fermentation. The microbes had been put to work with great success. But the butyl alcohol which had been sought at first was now a drug in the market — a surplus by-product — and accumulated in vast quantity. A new problem confronted the chemist, the answer to which came later.

With the end of the War came the new problems of what to do with these great War industries which had been created. Some of the plants ceased to operate, as has already been mentioned in the case of glycerin production. But at this juncture the skill of the peacetime chemist was brought to bear on the problem. Both acetone and butyl alcohol are (*Continued on page 238*)

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PUTTING GERMS TO WORK

(*Continued from page 236*)

excellent solvents for many organic compounds such as nitrocellulose or cellulose acetate — the material we find in rayon. They also react readily with other chemicals. A whole series of new industrial products have been developed, of which the lacquers have perhaps been most important. The Duco which gives such a durable finish and fine luster to your car, paint removers, varnishes, and a host of other products are the results. So valuable have they become that a constant and growing demand for these ultimate products of the work of bacteria has persisted; a new fermentation industry has grown from a War activity and become a flourishing and necessary peacetime one.

Lactic acid, such as we recognize in sour milk, is also a microbic product of many uses. When we speak of sour milk, the change in it is ordinarily looked upon as a defect, reducing the food and the commercial value of milk. When, on the other hand, it is sold as cultured milk or Bulgarian milk, kumiss, yoghurt, or by a variety of special names coined by dealers, we may gladly pay a much higher price for the product. Why? Largely because of the use of special types of bacteria which are used in a controlled fermentation, producing a mild acidity and flavor which is far from unpleasant. To us it may be an acquired taste, but in this respect it is not different from many of our experiences in viands and beverages, since from childhood we are continually experimenting in the gastronomic field. The popularity of these fermented milks became due, in a large measure, to Metchnikoff, who observed that in certain parts of Bulgaria and in the Near East there seemed to be a certain correlation between longevity and freedom from intestinal putrefaction, on the one hand, and the generous use of soured milk in the diet, on the other. Since in those countries all milk is extremely dirty and readily becomes sour, clean fresh milk as we know it in America is practically unknown. All milk, therefore, either sours spontaneously, or the action is hastened by warmth, possibly after the addition of some milk already soured. Metchnikoff examined the soured milk bacteriologically and isolated the prevailing organism, which he called *Bacillus bulgaricus*, and on his return to Paris introduced the soured milk as a curative agent for those suffering from dietary indiscretions. The results were often astonishingly favorable and never or rarely adverse, and sour milk therapy became widely known. Somewhat later a still better strain, known as *B. acidophilus*, was developed in this country, and has achieved considerable commercial significance.

The theory underlying this use of bacteria is simple. These organisms readily transform sugars, especially milk sugar, into lactic acid in the absence of oxygen, and the lactic acid thus produced in the intestinal tract restrains the development of putrefactive bacteria which (according to the hypothesis of Metchnikoff) acted on proteins, with the formation of toxic substances which were absorbed by the body. Thus one army of germs is sent to prevent the depredations of other germs in that 30-foot biological battleground in our intestinal tracts.

(*Continued on page 240*)

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PUTTING GERMS TO WORK

(*Continued from page 238*)

It has been known for generations that butter made from distinctly sour cream is of superior flavor and has good keeping quality. Not until 1884, however, when Storch in Denmark actually investigated the bacteriology of butter, was there definite knowledge. He demonstrated that presumably pure cultures of lactic acid bacteria could be used advantageously for souring cream which had first been pasteurized, but it remained for later investigators to prove that the best flavors could be produced by a joint action of lactic bacilli and some other organisms which bring about particular fermentations yielding the special flavor-giving substances. The famous Bacillus No. 41, isolated by Conn from Argentine butter sent to the Chicago World's Fair in 1893, was the first American culture which supplied both acid and flavor. In 1896, S. C. Keith, '93, of the Institute staff, produced the first duplex culture, containing the two types of bacteria required for the best results, but it did not prove a commercial success because of the detail required in its use and was soon forgotten. However, 23 years later Hammer and Bailey in this country and Boekhout and De Vries in Holland independently rediscovered the desirability of the coöperative effect of at least two types of organisms.

Ten years later it was shown that the substance, diacetyl, is responsible for the characteristic aroma of fine butter, and subsequently it was shown that diacetyl is produced by the action of bacteria on the citrates in the milk. The function of the lactic acid bacteria is to check other organisms and to lower the hydrogen-ion concentration to a point which permits the citrate splitters to carry on their work. Along with this action there is associated production of volatile acids and a number of other substances. A ripened starter, added to a large mass of pasteurized cream to be churned, can then supply the desirable flavor for the whole mass and yield a superior butter. Use of butter cultures has also made it possible to give a real butter flavor to high-grade butter substitutes such as oleomargarine, which are thus made excellent in taste as well as in actual food value. Lactic acid itself has many technical uses and has for years been made on a considerable scale. As lactic acid is a food acid, that is, can be utilized by the body as a source of energy, it may be employed in the manufacture of soft drinks, food preparations, in cheese making, and for medicinal purposes, as well as in processes such as dyeing, sour-mash distilling, and doubtless many other technical processes where a nonvolatile acid is desirable.

Germs have also been put to work in other industries. In the textile industries, the so-called retting of hemp and flax is a process in which microbes are employed to dissolve out the gummy materials which bind the individual linen fibers into stiff bundles, but which, on being released from this bondage, can be combed, spun into yarns, and woven into fabric. The dew ponds of southern England and Ireland and the famous river, Lys, in Belgium are natural habitats of these bacteria, and it was from such original sources that the cultures were obtained which were then forced to carry on their work in controlled captivity. The (*Continued on page 242*)

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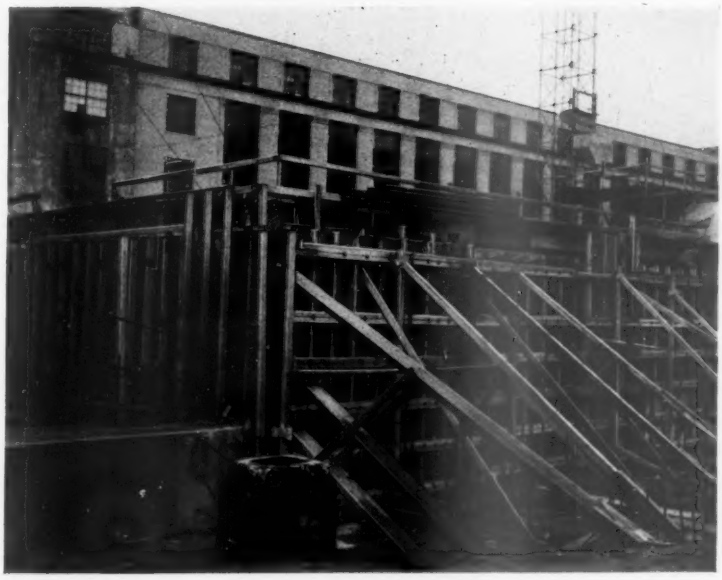

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PUTTING GERMS TO WORK

(*Continued from page 240*)

use of bacteria in seed inoculation and as nitrogen gatherers in association with leguminous plants is too well known to require any comment at this time. So also is the characteristic fermentation employed in making sauerkraut and in the pickle industry, although the specific organisms involved are less common than are some already considered.

Thus far the activities of yeast and bacteria have been especially mentioned. There are others equally interesting to the biologist, if not so spectacular or so obvious. But scant reference has been made to the utilization of molds, a class of microbic life of which one thinks generally with disgust rather than respect and admiration. Yet among these lowly and despised plants there are species which man has put to work in profitable ways. By one of these which has been developed in recent years, a new fermentation industry has come into being — the manufacture of citric acid.

For many years citric acid was known only as the natural acid of lemons, oranges, limes, and other citrous fruits. The acid itself, as a pure chemical, had a few uses — in medicine, for example — and still fewer industrial or other uses except as an occasional reagent. Most of the citric acid of commerce was imported from Sicily. A few years ago it was discovered that when certain molds, known as species of Aspergillus, are grown in shallow trays on the surface of nutrient cane-sugar solutions and in the presence of abundant oxygen, the sugar disappears. A part serves as food for the mold, while that not utilized by the fungus for growth is transformed into citric acid and oxalic acid and can be recovered in the form of pure crystals by proper treatments. Nearly all the commercial citric acid used today in soft drinks, foods, such as certain soups, and for technical uses in chemistry is now produced by fermentation. It is not a large industry, but it is likely to be a growing one, for chemists find ways of utilizing such products in unexpected quarters.

A highly useful yet rather curious example of mold utilization which has been practiced for untold years is of general interest, *i.e.*, the part these organisms play in the ripening of soft cheeses such as Brie, Camembert, Stilton, Roquefort, and Gorgonzola. Port du Salut, originated by the Trappist monks in France, later produced in Spain and, with the expulsion of the order, brought to the wilds of Canada, belongs to this group. In most of these the molds and bacteria work in a sort of partnership, the bacteria first producing a mild acidity in the curd which then becomes a favorable breeding ground for molds. The brunt of the work falls on the fungi which, because of their great ability to produce those interesting digestive juices or secretions known as enzymes, can partially transform the raw casein of milk to nutritious and highly satisfactory cleavage products. Cheese is, therefore, to a large extent a predigested food, with characteristic tastes and odors.

One of the technical uses of mold fungi depends upon the great ability of these organisms to secrete enzymes of considerable variety and quantity. The commercial product, Takadiastase, which (*Concluded on page 244*)

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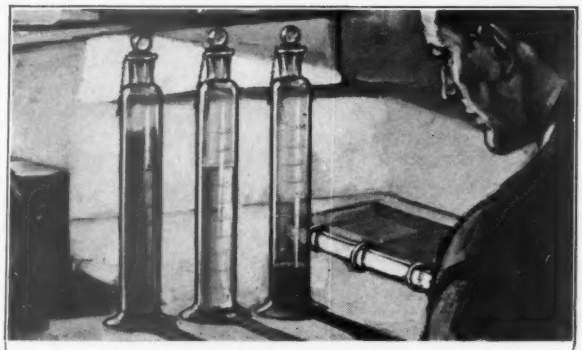

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PUTTING GERMS TO WORK

(*Concluded from page 242*)

has been on the market for many years, is such a material, first derived from the fungus *Aspergillus oryzae* by the Japanese mycologist, Takamine. Its qualities and powers are essentially the same as malt diastase from sprouting barley, but it can be prepared with greater ease and economy.

Among other uses of molds which may become of technical significance, one is in the manufacture of kojic acid. Although of no apparent use at present, the acid possesses a gamma-pyrone nucleus which is difficult of synthesis but may conceivably be important in the future. The same statement could have been made a few years ago with reference to gluconic acid — now produced by molds as well as by bacteria. The calcium salt of this acid is now used in medicine as a means of introducing calcium into the body.

Some molds are also known to be capable of producing ergosterol, which, by irradiation, can be transformed into Vitamin D. This is already being done commercially in this country. Even more curious is the fact that some species of Helminthosporium can produce pigments which are actually anthraquinone dyes. These are now being developed commercially in Great Britain, as production by mold growth is cheaper than by organic synthesis.

This paper has touched upon some of the ways of harnessing microbes for man's service, which have taken place especially in our own lifetimes. Some of them are of ancient practice; others are still in the early stages of utility. There are numerous others, possibly less promising and less exciting, which might be described, for we are apparently at the beginning of an era of microbiological development which may be of vast interest. What has already taken place indicates clearly that industrial microbiology is a growing branch of science and an interesting one. What we may expect in the next quarter century is a field for scientific use of the imagination and theoretical speculation, but most of all for originality and accuracy in pioneering research.

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SCRIMSHAW—THE PERFECT HOBBY

(*Continued from page 224*)

I think of at the moment: a cane made up of sections of ivory (see page 224), with a snake winding along its total length; and a miniature wheelbarrow (page 221), finely proportioned.

The second material of scrimshaw, the lower jawbone of the sperm whale, was nearer wood than ivory. It had a definite grain, but a grain without any particular beauty. Its chief advantages were that it could be more easily worked than the tooth — although nowhere near so delicately — and that it could be obtained in large pieces. The jawbone came in two cuts, as it were: the long, straight shank that held the teeth, and the pan at the joint, from which a broad rectangular slab could be obtained. Canes, yardsticks, boxes, and busks could readily be made out of jawbone, and it was generally used for the latticework of the swifts, or yarn reels.

Whalebone, the third important scrimshaw material, was of ugly brown color. Its flexibility — the property that made it valuable commercially for ladies' stays, umbrella ribs, and whips — made it useful for certain purposes in scrimshaw. I have seen canes wrapped spirally with whalebone about half an inch wide. Occasionally whalebone was used to good purpose as inlay. The most common use of whalebone in scrimshaw was for busks; these the whaleman often engraved, but though the designs are generally interesting, the artistic effect is not fortunate.

Scrimshaw would not have flourished so widely and so passionately (I do not believe the latter is too strong a word) had it not been for the triumph inherent in the art. The teeth, the busks, the jagging wheels were trophies, won in great peril and enthusiasm. The scrimshaw artist had known the actual whale which had furnished his material. He had felt and smelled the vapor of its spouting; perhaps he had felt the swish of the broad flukes, or seen the animal bite a boat in two, or been spattered with hot blood in the death flurry. There were countless bitter, elemental fights between man and beast in the desolate wastes of the ocean; these were flashes of glory in a dreary existence.

Scrimshaw, then, was inevitable, for the perfect material was at hand — perfect for the zeal of the craftsman, perfect for the pride of the whale hunter. And time was at hand, and loneliness, and ennui, and the instinctive yearning for beauty. There is still another phase to scrimshaw, of which I am reminded by a remark heard recently concerning the desirability of cultivating hobbies of social nature. Now scrimshaw, like wood carving or etching, is intrinsically a solitary pursuit. Yet it would hardly have flourished without its social setting. A group created it, and a group, through emulation, perfected it. There were no schools or textbooks, no Aristotles or Ruskins; a definite technique was developed through (*Concluded on page 246*)

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SCRIMSHAW—THE PERFECT HOBBY

(*Concluded from page 245*)

intercourse alone. The scrimshaw of an individual voyage would often have an individual stamp — but only in respect to the designs chosen or the type of article most generally attempted — and this would be due to the influence of some natural leader. The best glimpse we can get of scrimshaw, I imagine, is in picturing some young green hand scratching crudely on a scrap of bone and at the same time watching with anticipation an old veteran of the sea putting the flutings on a jagging wheel. There were some rare ships on which the captains forbade scrimshaw as a trivial pursuit damaging to discipline. But on the whole, the making of scrimshaw was common to cabin, steerage, and forecastle. Of course there must have been many seamen who would not even attempt the art, like the grouch who wrote in his journal: "Nothing in sight and no signs of ever beeing any spirm whales around here the old man and the mate devote their time a Schrimshorning that is all they think of."

Just when and how scrimshaw came into being no one seems to know. My guess is that it must have started after 1712, the year that the Nantucketers discovered the sperm whale. I feel that the large and beautiful teeth of that species would have aroused the artistic urge in some of the islanders. If a piece of ivory is in one's possession, especially as a trophy, what would be more natural than the desire to smooth it down, to beautify it? But there is an even chance that I am wrong and that the first scrimshaw was done by some swain who, in a moment of frivolity or sentiment, took out his jacknife and carved a heart into a whalebone busk. In either event, the work would have to be called "land scrimshaw," for the long voyages, so essential to the real scrimshaw, did not begin till mid-century. Crèvecoeur wrote in 1782 of the numerous trinkets he had seen in Nantucket, all carved by the whalemen during the leisure of the voyages. The earliest reference to the art I have found in a logbook is of 1826: "All hands employed Scrimshonting." Between the two dates last mentioned, the American whalemen had rounded the Horn and had mingled with the natives of the South Sea Islands. How much the Yankee scrimshaw owes to the patient art of Polynesia, one doesn't know. In subject matter it seems to owe nothing; and in technique probably little. But when one considers some intricate Polynesian carving, done in the hardest of woods, without the aid of metal and with a bit of shell for a knife, one supposes that the whalemen might well have found a new patience, a new ideal, from those brown-skinned masters of leisure.

The point cannot be settled, for the objects seen by Crèvecoeur are not to be collected, and, so far as we know, all existing scrimshaw belongs to the post-Polynesian years. Yet it would not be surprising if some one traced the word "scrimshaw," a word that has still escaped capture, to a South Sea origin.

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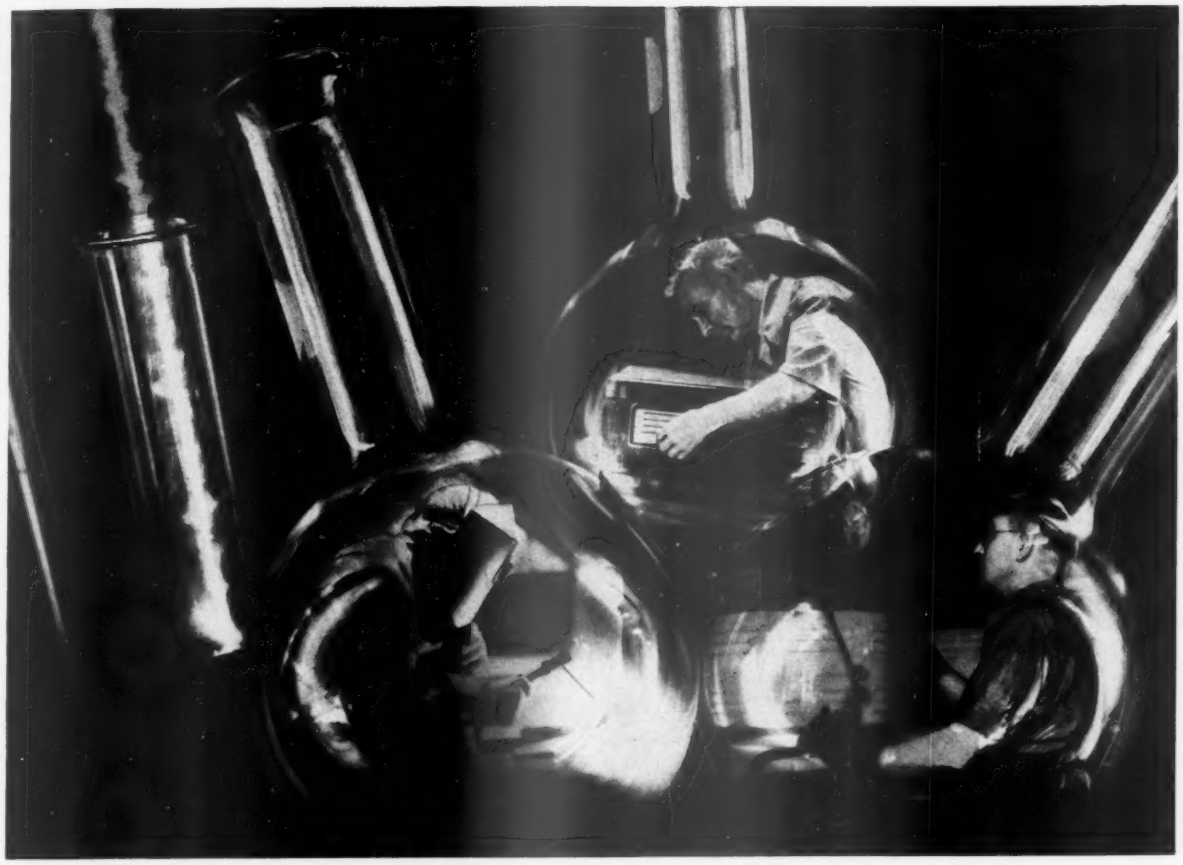

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